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EDITORIAL NOTES—GAS, &c.

Beginning to Share the Fruits of the New Policy.

THE Gaslight and Coke Company have made many moves of late; but not the least in causing the proprietors pleasurable sensation will have been the proposal of the Board to declare a higher dividend than hitherto for the past half year. A pleasurable sensation from such a cause has long been absent from the enjoyments of the proprietors of this Company; and it is now due to the very serious and purposeful overhauling that the policy of the Board and operations generally have of late been subjected to. That they required it, the tangible issue is the best of proof. All too long the proprietors placidly sat under a policy that gave neither them nor the consumers any advantage. The price of gas and the dividends appeared to have been completely petrified by time; and the market price of the stocks (no one could blame the dealers) showed a steadfastness in declining to advance to par value. True, meter-rents have been restored, giving to the Company less than £60,000 a year. But, on the other hand, £80,000 have been handed over to the consumers by a reduction of 1d. in price; proprietors are to receive on this occasion an addition of 2s. 8d. per cent. (representing a supplement to the total distribution of rather less than £10,000 for the half year compared with twelve months ago); and the market buying price of the stock has reached par. These are only the beginnings; but they are real beginnings in the sharing of the fruits of the new policy.

In considering the accounts on this occasion, there are three points to be particularly borne in mind. The one is that the past half year is comprised within the period of the extreme prices for coal in connection with the late boom; that the figures compare with a period when the prices of raw materials were much lower; and that the whole of the half year has been subject to the 1d. reduction in the price of gas, discounted by the ¾d. in the gain on the part of the Company from meter-rents. Remembering these points, the first thing to be noticed is the very small difference in the balance on the half-year's trading. The balance is £406,433, or a decline of £4773 compared with the first half of last year. With the sum brought forward, there is available for distribution £755,984, an increase of £114,825, which is represented, with the £4773 decline in the balance, by the additional £119,598 brought into the half-year's accounts compared with the similar item in the corresponding period of last year. The higher dividend on this occasion will require £343,661, or an addition, contrasted with twelve months ago, of only £9645. The dividend has been considerably more than earned in the half year; and the result is that £412,298 is being brought forward to the accounts of the current half year, compared with £306,992 at this time last year, and the £349,551 brought into the past half-year's accounts. This shows that there is being carried forward sufficient to pay another half-year's dividend, and nearly £69,000 towards the £200,000 or so needed to pay a half-year's interest and dividend on debentures, temporary loans, and preference and maximum stocks. This is a very satisfactory financial position.

Taking a glance at the capital account, nothing has really been added during the half year; for, though there was an expenditure charged to the account of £39,547, depreciation of plant, meters, and stoves was charged to the amount of £41,546; and adding the difference of about £2000 between these two sums to a credit of £14,964 derived from the sale of surplus land, it is found that the total capital expenditure as it stood at Dec. 31 last has actually been reduced by £16,963. This is a wholesome condition of affairs. Not less significant are some of the items of the revenue account; and there is considerable interest to be drawn from their examination. The item of coal stands at an increased cost of £105,427; oil, at £2092 more; and coke for the manufacture of carburetted water gas, at £4075—together £111,594. But against this there were decreases in the charges for wages of £7650, of £5572 in purification, and £28,379 in repairs and maintenance of works and plant. If for the moment we turn to the income side of the account, something approaching a coincidence is revealed. The increased receipts from residuals amounted to £69,901; and savings on manufacturing charges came to £41,601—or together £111,502, which is only short of the increased sum paid for coal, oil, and coke by the amount of £92. While on this question of the cost of the raw materials used in manufacture, it may be pointed out that, though there was nearly ½ per cent. less gas sold in the half year than in the corresponding period, there were 16,442 tons of coal more carbonized, and 419 gallons more spirit were used, but 427,142 gallons less oil—above 71 million cubic feet less carburetted water gas having been made. The total figures will all be found in the accounts. However, the sum of the manufacturing charges (without deduction for the increased receipts from the residuals) was higher by £70,011. The other items of expenditure do not call for comment; but it will be observed that there is an increase of some £2000 in bad debts. The total of £7505, however, is only about a third of 1 per cent. on the whole income of the Company. The total expenditure of £1,574,359 is, owing to the higher cost of materials, £82,170 more than in the corresponding half of last year.

On looking at the other side of the account, it is seen that this increase is submerged, with the exception of £7210, by the increase in revenue of £74,960, the total of which was £2,196,142. In view of the reduction of 1d. in the price of gas, the receipts under this head are of peculiar interest. The reduction it was estimated would represent about £80,000 a year on the consumption of gas. The consumption has been practically stationary. This is disappointing in a degree, though there can be no controlling by the best of Boards of meteorological conditions, nor of the fascination of thousands of customers for spending their evenings at such places as the White City. The drop in the gas receipts, as a consequence of the reduction, has been £31,718; but against this has to be set the meter-rental of £29,028, and an increase of about £6000 in the rental of stoves and fittings. In view of these increases in rental, and the fact that the half year has gathered in an additional connection of 10,331 consumers and 13,161 stoves, there need not be even momentary alarm over the slight diminution in consumption. But we come to the residuals; and they show an aggregate increase of £69,901. In every commodity in this department there has been an increase—in coke of £55,882, in breeze of £7687, in tar and tar products of £4225, in ammoniacal liquor and sulphate of ammonia of £2107. It must not be expected by the proprietors that the prices of coke will be maintained in face of reduced coal prices; but here again in the current half year there will be compensation in a reduction in cost for coal, for the Directors report that contracts for the supply of coal and oil for the next twelve months have been made at prices showing a "material" reduction on those which obtained during the previous twelve months.

This scrutiny of the statement that will be laid before the proprietors leads us to anticipate with every confidence that they will unanimously vote it, at their meeting on Friday, as financially excellent, and as casting in bold relief the soundness of the new policy.

The Higher Price in South London Justified.

THE accounts of the half year of the South Metropolitan Gas Company show clearly that the Directors acted with wisdom in increasing the price of gas to 2s. 3d. last Midsummer; for notwithstanding a decrease in consumption of gas, compared with the first half of last year, the Company are able to meet out of the six months' profits all their

obligations to the full, and start the current half year with a clean slate, by wiping off a suspense account of £9669 and the deficiency of £8464 on the accounts to December last, and to carry forward £5876, in addition to which they have the substantial and gratifying backbone of £300,000 in the reserve and insurance funds. All this is solely attributable to the increase of 3d. in the price of gas, which price for London is low and satisfactory to the consumers. We do not think it will be found that the decrease in consumption of gas is due in any degree to the increase in price, but is owing, in large part, if not entirely, to the atmospherical conditions of the half year and the increasing use of incandescent burners. We have heard it said that the slow progress in gas consumption in South London may be due to another cause—to the almost imperceptible but sure change that is taking place in some of the residential parts of the Company's area of supply. Admittedly, there are certain restricted areas from which migration of the old ordinary class of consumer has been steadily going on, and their places have no doubt been more than filled by the prepayment class of consumer. The change, however, would hardly account for any diminution in consumption. It is true that the number of ordinary meters in use, compared with twelve months ago, shows a reduction of 1856; but this pales before the 15,719 new prepayment connections, the 1997 additional stoves fixed in ordinary consumers' houses, the 17,890 stoves fixed in the houses of slot meter customers, and the 744 extra fires that have been fitted up. So that, with this substantial expansion of the outlets for business, the decrease in consumption must be solely ascribed to natural causes.

However, the profits of the half year, notwithstanding the heavy addition to the cost of coal, of £50,850, were sufficient to wipe off the sums named in the opening lines, and to pay the full dividend to which the proprietors are entitled; and £5 6s. 8d. per cent. is not a bad dividend. As a matter of fact, it is only 3s. 4d. less than the proprietors had been receiving before the increase of 3d. in the price of gas took place; the reason the reduction is no more under the sliding-scale being that the proprietors were formerly contented with a dividend of 5½ per cent. instead of the £5 14s. 8d. to which they were really entitled at the 2s. price. But now that the dividend conforms with that to which the proprietors are entitled, the Directors are fully determined that, as between proprietors and consumers, the principle of the sliding-scale shall in future be rigidly adhered to. This is only fair when a Company are doing business at the low price that this one has reached, and the dividend to which there is title at even a 2s. price is not an unreasonable one for a trading enterprise. In this respect, too—that is to say, in respect of the division of profits—there has been a clearing of the slate, and a fresh start made; and there has not been complaint from any section of the co-partnership. It is satisfactory to learn of the philosophical attitude in the matter of the employee proprietors. They have suffered a reduction of bonus, a lessening of dividend on their stock-holding, and they have to pay more for their gas. For them, co-partnership is not a mere gossamer fabric. It is a serious business; something very tangible and very real. And such temporary reverses as the present do more to bring this home to them than would a perpetual run of "good luck." The temporary reverse is not a pleasant thing for anybody; but it has in a measure its good influence.

The increased cost of coal is, of course, the black spot on the accounts; the additions being £50,850, though a rather smaller quantity of coal was carbonized. There is not by any means a cheerful tone in the report over this question; and it is hardly one over which there can be a song of triumph. Under the current year's contracts, reduced prices are being paid; but the reduction is not to the extent that might have been expected in view of the position of trade. As a matter of fact, the price to be paid (f.o.b. Tyne) is some 40 per cent. higher than it was three years ago. However, there has been a decrease in price; and that is something to the good. The Directors do not give any intimation as to a reduction in the price of gas to their consumers. The horizon is not clear yet; and the Board are rightly under promise to see their way plain to the means in future for carrying out their share-and-share alike policy within the limits of the statutory authorization. Among the uncertainties of the future is the Coal Mines (Eight Hours) Bill. No one can speak with any authority as to the fate of this Bill. It is hung up now to the autumn session in company with several other highly contentious and characteristic measures of the Government; and there is doubt as to whether time will permit of the Bill passing. It is to be hoped the doubt will develop to an actuality in correct form. We are not quite sure that the Government are not feeling a little uneasy over the dual position in which they find themselves in this matter, of being the puppets of the Miners' Federation and the enemies of industry and the householder. And it may be that they will be glad enough, if they can legitimately plead want of time, to sacrifice a measure that is uncalled-for and that threatens an infinity of injury.

A few words on the items of the financial statements. From the revenue account, it is seen that the £50,850 increase in the cost of coal has only about £19,000 increase in the receipts for residuals to set against it, made up of an additional income from coke of £14,756, from breeze of £2503, and from sulphate of ammonia of £5360, less a reduction of £3521 from tar. On balance, the manufacturing charges show an addition of £50,634, and the distribution expenses of £40,382. The distribution charges reflect the great change that has come over the business of gas supply; and the Directors in their report comment upon this. It is significant that in the past decade the number of consumers in the Company's district has increased by no less than 94 per cent., while gas consumption has only advanced by 37 per cent. But all this additional expense and connecting up of consumers means business reinforcement. Looking down the items of expenditure under distribution, there is one grim announcement; and it is that during the half year no less than 6315 slot meters were damaged by robbery. This is an increase of upwards of 2000 on the previous half year; and, in the twelve months, the number of meters so feloniously maltreated numbered 10,458. This is serious; the total amount stolen from them being £1050, without calculating the cost of repair. The average sum stolen is only about 2s. per meter; and the facts all seem to point to banded and systematic thieving. The total expenditure incurred for the half year (£852,446) shows an increase of £87,451; while the revenue of £1,072,735 represents an increase of £88,150, so that the extra expenditure is covered, and with £699 to the good. Of the increase in receipts, gas contributed £66,849; rental of meters and stoves, £2219; and residuals, £18,998.

Considering the low price of gas and the additional cost of coal, the proprietors will look upon the accounts as highly satisfactory; and had not the atmospheric conditions of the half year been against the Company, so as to produce a decrease in consumption, a still more gratifying financial condition would have been disclosed in the report and accounts, which nevertheless possess so many points of interest.

The Largest Gasholder in the Provinces.

An event of the past week that deserves special remark is the laying, by Mr. Alderman Gibson, the Chairman of the Manchester Corporation Gas Committee, of the foundation stone of a 10 million (or nearly 10½ million) cubic feet gasholder at the Bradford Road Gas-Works. The interesting feature to the gas engineer is the size of the holder. It reminds that gas undertakings in the Provinces are gradually creeping up to the one distinguished exception in the matter of gas storage capacity that London can boast, and which exception was the work of the illustrious leader in the art of gasholder construction of large scale capacity. The 12 million holder at East Greenwich has been of late years the only one, in point of storage magnitude, that London could point to as having been unmatched in the Provinces; for the 8 million holders in the Metropolis have had their equals in Glasgow, and other large centres have not been far behind in the capacity of their latest storage structures. We are not pitting the Provinces against London in this respect; but the fact that Manchester is reducing by a further 2 million cubic feet the pre-eminence of London in this regard, and leaving it in advance by only 2 millions, is a matter of something more than passing interest to gas engineers. This Manchester holder, when completed two years hence, will rank as the largest in the Provinces, second to the gigantic structure at East Greenwich, and the third largest holder in the world.

Although these are the days of records on the olympic scale, the Manchester Corporation Gas Committee and their Chief Engineer (Mr. J. G. Newbigging) have had no idea of undertaking the construction of a holder of such capacity as 10 million cubic feet with the object of lowering previous provincial records, nor of halving the difference between

provincial record and that of London. With them it has been all a question of expediency. The ever-rolling progress in gas consumption (not since 1897-8 has there been a set-back in any year in the output of the city) is a sufficient justification for carrying out a holder of such magnitude; and there are the important supporting reasons that a site was available for a holder of the dimensions of this one, but not of an extent equal to two of somewhat smaller capacity, and that the larger holder could be constructed at a considerable reduction in capital outlay per 1000 cubic feet capacity. Reduced capital outlay per 1000 cubic feet means lessened average capital charges; and, therefore, where there is an excellent expansion in consumption, and where a large holder can be usefully employed to meet such eruptions in demand as are encountered in a city of the industrial cast of Manchester and to assist in maintaining a straighter line in the gas-making curve, there is plenary vindication for the construction of holders on these larger scales.

Touching first the point as to the controlling importance of gas consumption over storage provision. With the extended use of gas in the daytime for industrial purposes, and the extended day domestic consumption for cooking and heating, any violation of the rule laid down in 1874 (perhaps before, though unpublished) by the father of the present Chief Gas Engineer at Manchester, that storage capacity should be equal to at least twenty-four hours' maximum production of gas, would more than ever now, in times of continuous heavy fogs, produce feelings in those responsible that would be traceable in pensive visages during the times that they were being hard put to it. The rule that Mr. Thomas Newbigging framed so long ago, he has seen no reason to depart from since, though the conversion of the term "pro-"duction" to "consumption" might be an improvement. The rule is the one that governs the Corporation Gas Committee of Manchester. Many years ago they had the lesson that procrastination in this matter administers to those who ignore the rule; and they are not disposed to have a repetition of it. In 1897, in storage they were 5 millions behind the maximum day's consumption; and notwithstanding that they subsequently extended the storage by the erection of a 7 million cubic feet holder, to-day finds them again nearly 5 million behind the rule, seeing that their total gasholder capacity is 24,510,000 cubic feet and the maximum day's consumption is 29 millions. Two years hence with the new holder the storage will be up to between 34 and 35 million cubic feet; and before then the maximum day's consumption will no doubt have still further diminished the margin between the present maximum day's consumption and prospective storage ability. We do not forget the valuable aid of carburetted water-gas plant in meeting sudden flights in consumption, any more than we do not forget that it was not very long ago that Mr. William Newbigging, when choice was being made at Macclesfield between a carburetted water-gas plant and gasholder storage, advised (for stated reasons) in favour of the latter. However, it will be agreed that Manchester has not entered on this work any too soon; and that the large size of the holder is fully justified by the circumstances of the city in relation to its gas supply.

Manchester may be congratulated in that they will be securing this great increase in gas storage at a cheaper rate per 1000 cubic feet of gas than their storage has hitherto cost them. Holders constructed in Manchester rather more than a quarter of a century back cost an average of £21 per 1000 cubic feet; the last 7 million cubic feet holder cost £11; and the new one is going to cost £8 os. 7d. per 1000 cubic feet. But this £8 os. 7d. is subject to some reduction owing to the fortuitous circumstance that the site is convenient and the spoil suitable for the making of bricks for the tank; and the tank contractors have entered into arrangements to utilize the convenience and enjoy the economy by agreement with the Corporation. Whether or not £8 os. 7d. per 1000 cubic feet is a fair figure for a 10 million feet holder depends on several conditions from the tank upwards, together with the market conditions of the time. The 12 million holder at East Greenwich only cost an average of about £5 per 1000 cubic feet; and that is the foremost instance extant of cheap gasholder engineering. There are examples of 8 million cubic feet holders whose cost works out at something like £8 per 1000 cubic feet. We are not quite sure, and so should not like to speak definitely; but it may be that the broom which Mr. J. G. Newbigging nailed to his masthead on Wednesday may have to be lowered a bit. His statement was that the "cost of the holder per 1000 cubic feet will be £8 os. 7d.; "but this will be lessened by arrangement with the tank con-"tractor for brickmaking and clearing the site. The holder "will then be the cheapest structure of its type in the "country—that is to say, a holder guided to its full height, "although the market for steel is not very favourable." However, the building of this 10 million cubic feet holder at Manchester is a very interesting event; and Mr. J. G. Newbigging is to be complimented upon having such a particularly fine opportunity of winning his spurs as a designer and constructor of gasholders of large dimensions.

What is a Trade Dispute?

In connection with section 3 of the Trades Disputes Act, 1906, the Court of Appeal were last week called upon to decide whether or not a certain condition of affairs constituted a "trade dispute." A member of a Trade Union seven years ago had a fine imposed upon him by one of the branches; and this had never been paid. Later, he left the Union; but on rejoining recently, the question of the unpaid fine was revived. An official of the Union (though acting without the authority of the Executive) then went to the man's employers, and threatened to call the other men out if he were not stopped off. The victim of this piece of tyranny brought an action against the official who had thus procured his dismissal, on the ground that he had done it maliciously, by threats and coercive acts. The defence was that the facts showed there was a trade dispute, and defendant claimed that he was entitled to the benefit of section 3 of the 1906 Act, which provides "that an act done by a person in contemplation or furtherance of a trade dispute shall not be actionable on the ground only that it induces some other person to break a contract of employment, or that it is an interference with the trade, business, or employment of some other person or with the right of some other person to dispose of his capital or his labour as he will." Section 5 defines "trade dispute" as meaning "any dispute between employers and workmen or between workmen and workmen which is connected with the employment or non-employment, or the terms of the employment, or with the conditions of labour of any person;" and the expression "workmen," as meaning "all persons employed in trade or industry, whether or not in the employment of the employer with whom a trade dispute arises." A Jury in the Durham County Court found that there was not a trade dispute existing or contemplated by the men, and awarded plaintiff £50 damages. The County Court Judge refused an application for a new trial; and the Divisional Court supported the refusal. The Court of Appeal have now come to a different conclusion, and allowed the defendant's appeal; but it is apparently intended to carry the case to the House of Lords. The Master of the Rolls, in giving judgment, said it seemed abundantly clear that there was an existing trade dispute—namely, a dispute between some members of the Union and the plaintiff arising out of the non-payment of the fine. He pointed out that, under the Act, a "trade dispute" could not be limited to a dispute between a body of men on one side and a body of men on the other. It included a dispute between an individual on one side and a body of men on the other. But strange to say, it did not include a dispute between employers and employers, though it expressly included a dispute between workmen and workmen.

The Cause of a Strike.

Towards the end of last week, a good deal of uneasiness was felt in the Welsh coalfields in consequence of a labour development at the various collieries of the Powell Duffryn Company. It was stated that 6000 men had left work without notice; and, of course, there was general anxiety to ascertain just what had given rise to so serious a state of affairs. A meeting was subsequently held at which a resolution was unanimously passed confirming the action of the men's agent in calling the colliers out, and pledging the men to remain idle until the various grievances complained of were redressed. To warrant such a step as had been taken, the grievances must have been of a very serious character indeed; and yet some at least of them do not appear to merit such classification—judging from the explanation of the agent, who may fairly be assumed to have put the best complexion possible on the men's case. It was complained that some men were overworked and were unjustly dismissed; that

deputations of the men had been treated with incivility to such an extent that it had at last become unbearable; that people visiting the office to fetch compensation allowances for their husbands or fathers were treated with rudeness and discourtesy by subordinate officials; that the compensation doctor thrust himself into the men's houses oftener than the once a month he was entitled to; that "poor sufferers were thumped about; and that then the medical testimony in the Court before Judge Bryn Roberts was that if a man suffered as he said he did, he could not bear the punishment inflicted upon him." The agent added that "they knew Mr. Bryn Roberts did not pose as a friend of the workmen, but rather as a 'Boss Union Smasher' who tried to ruin their Federation by piling up expenses and giving verdicts against them." Another point made was that there was general dissatisfaction on the question of safety at the collieries, in spite of frequent favourable reports of the Government Inspectors. As is the case with most strikes, this one has begun with much confident speech by the men's leader, who boasts that he has broken the law and the Conciliation Board agreement—justifying his action by the assertion that it was the only way of getting the grievances redressed. It is an old story; but its repetition at this particular time furnishes a striking contrast to the gathering of the South Metropolitan and South Suburban Co-Partners at the Crystal Palace last Thursday, a report of which appears in another column. In face of such evidence as is provided by the "official reasons" for this strike, who can deny the need for a change of relationship between employers and employed?

GASLIGHT AND COKE COMPANY'S REPORT.

THE following is the report on the working of the Company during the six months ending the 30th of June last, which, with the accounts [see p. 340], will be submitted to the proprietors on Friday.

The accounts for the past half year show that, after providing for fixed charges, setting aside £10,000 for the half year towards the redemption fund (in accordance with the provisions of the Company's Act of 1903), and carrying £10,000 to the insurance fund, there remains a balance of £406,433 19s. 1d. The amount brought forward from the previous half year being £349,551 0s. 9d., there is a total sum available for distribution of £755,984 19s. 10d., out of which the Directors recommend a dividend on the ordinary stock at the rate of £4 10s. 8d. per cent. per annum, which will absorb £343,661 13s. 9d. The sum to be carried forward to the credit of the current half year is £412,298 6s. 1d.

The sales of gas for the half year show a decrease of not quite ½ per cent. compared with the quantity sold during the corresponding period of 1907.

The Directors have to report that contracts for the supply of coal and oil for the next twelve months have been made at prices showing a material reduction on those which obtained during the previous twelve months.

During the half year the Company have added 10,331 consumers, and there has been an increase of 13,161 in the number of gas-stoves sold and let on hire.

The Court of Directors have been furnished by the several Engineers of the Manufacturing and Distribution Departments respectively with the usual certificates that all the Company's plant has been maintained in thorough efficiency.

SOUTH METROPOLITAN GAS COMPANY.

Half-Yearly Report.

THE following is the report of the Directors of the Company for the half year ended the 30th of June, which, with the accounts [see p. 340], will be presented to the proprietors at the ordinary half-yearly meeting on the 12th inst.

The accounts now presented show a satisfactory amount of profit, enabling the Directors to recommend the payment of the full dividend at the rate of 5¾ (£5 6s. 8d.) per cent. per annum, to which the shareholders are entitled under the sliding-scale, to clear the balance-sheet of a suspense account of £9669, to meet the deficiency on the accounts of December last of £8464, and to carry forward £5876 to the next accounts, in addition to reserve and insurance funds of nearly £300,000.

The expenditure of the Company is set out in the revenue account under various headings—"Manufacture," "Distribution," &c. Compared with the corresponding half year, the cost of coal used in manufacture, for a rather smaller quantity, is increased by £50,850; and your Directors regret to report that, though the coal contracts for the current year have been made at a reduced price, the reduction is far less than could have been reasonably expected considering the present depressed condition of trade. The price of coal free on board in the Tyne is now about 40 per cent. higher than it was three years ago; and the Coal Mines (Eight Hours) Bill will certainly, if passed, add to the cost of getting coal. The extra receipts for coke are £17,259, equal to about one-third the extra cost of coal. The receipts for tar are about £4000 less, and those for ammonia about £5000 more, than in the June half year of 1907. The expenditure on distribution has considerably increased; the cost per 1000 feet sold having doubled the last ten years. This is largely due to the fact that the number of consumers has increased 94 per cent., while the consumption of gas has only increased 37 per cent. In addition, much more work of various kinds has to be done in the district than formerly, necessitating a much larger staff of officials and workmen, as a consequence of the totally different system of lighting, and the development of gas as a heating and manufacturing agent. The greatly improved methods of using gas have reduced consumption, but at the same time have enormously increased efficiency. The result is two-fold—more light from less gas, and a strengthening of the position of the gas companies.

The co-partnership sliding-scale bonus to the employees to be invested in ordinary stock for the year to June 30 last amounts to £36,426. It is £9000 less than last year, due to the higher price of gas caused by the increased cost of coal. Not a word of complaint has been heard, for employees of all ranks recognize and acknowledge that, when adverse circumstances arise which neither consumers, shareholders, nor employees can control, it is perfectly fair that the burden should be shared. When consumers have to pay more for their gas, shareholders receive less dividend and the co-partnership bonus is reduced. Employees, however, are contented, though they have lost not only in their bonus, but also as shareholders in dividend on their stock and as consumers of gas in their homes. Their pecuniary interest in the Company is now well over £350,000; and, as was lately remarked by an inquirer, it is probable that there is no body of employees in existence with such a holding in the business in which they are engaged. The Directors believe that the system is equally, as it should be, to the advantage of the Company and the employees; and they are able to say that during the nineteen years of its existence the Company has been absolutely free from anything in the shape of a difficulty or difference with its servants. They have also much pleasure and satisfaction in bearing testimony to the good service rendered by all grades of officials and workmen.

GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 350.)

THE Stock Exchange had a short week to conclude the month with (for Saturday was a closed day), and, moreover, one regarding which few pleasurable anticipations could be entertained after the discouragement of the week before. But happily the result was better than the outlook. The opening on Monday was beset by anxiety (the heritage of what had gone before); and the first movements were disposed to be adverse. After awhile, however, better views prevailed, and the tendency became more cheerful. There was an arrest of realizing, and a fair amount of buying of gilt-edged securities for investment took place. Consols rose ⅜; Home Rails, though at first very shy, improved on a dividend announcement; and the American Market, after some shiftiness, closed better. Tuesday opened under the influence of the previous day's recovery. Consols hardened, but were too tender to bear quick treatment, and gave way again. Home Rails held on pretty firmly, and the rest were fair. From this point the air seemed to have calmed, and business was done on a fair scale, considering it was account week and the end of the month, and that fresh commitments were not sought. The account was a light one, and involved only one slight mishap so far. Consols improved fractionally, but gave way again. Home Rails were disheartened by trade and traffic prospects; but another fair dividend report on Thursday revived them. In the Money Market, there was an ample supply to meet all the demands without affecting rates much; and discount was steady. In the Gas Market, business began to shape on a holiday scale such as befalls it in August. But the general tendency was excellently firm; and what few changes were made in quotations were all in the upward direction. In Gaslight and Coke, the ordinary was done at from 99 to 99¾ (a rise of ⅛). In the secured issues, the maximum was dealt in at 88½ and 89½, and the debenture at 84½. South Metropolitan was firm and unchanged, with dealings at from 119½ to 121. In the Suburban and Provincial group, Alliance and Dublin new changed hands at 13¾ and 13⅛, Brentford old at 245 and 246, Tottenham "B" at 108, and West Ham at 102. In the Continental Companies, Imperial was unaltered at from 179⅝ to 181, Union was done at 112½ and 111½ free, and European fully-paid at 23. Among the undertakings of the remoter world, Buenos Ayres realized 11¼ and 11 5/16, Melbourne 5 per cent. 101½, Primitiva 6, ditto preference 5⅛ and River Plate 13⅝ and 13½.

At a recent meeting of the Illuminating Engineering Society, at Chicago, Dr. H. Gradle read a paper on "Illumination and the Eye." He dealt mainly with the effect of varying degrees of illumination on the eye, and showed that what the eye considers good illumination is largely a matter of comparison or contrast.

ELECTRICITY SUPPLY MEMORANDA.

Accidents in Factories—Dangers of Common Voltages and Ordinarily Constructed Electric Hand Lamps—Unequal Distribution of the Power Business—Cash Prices and Hiring Rates for Motors—Lighting Westminster Bridge—Decline in Provisional Order Applications—The Prepayment Business.

THE annual report of Mr. G. Scott Ram, the Chief Inspector of Factories, Workshops, &c., again testifies to the necessity for a more effective supervision of industrial establishments in which electricity is employed; and it abundantly justifies the Home Office in their plans for endeavouring to secure that supervision. The generating-stations of local authorities and private companies have during the year been fairly free from fatal accident directly traceable to electricity; but in factories, engineering shops, &c., the death roll is rather heavier, and the non-fatal accidents have a substantial total. In the electricity generating-stations of local authorities and companies in 1907, there were 246 non-fatal and seven fatal accidents that were non-electrical in their origin; and 48 non-fatal and two fatal that were electrical. In private generating-stations, there were of non-electrical accidents 28 non-fatal ones, and one fatal; while of electrical accidents, eight were non-fatal and one fatal. Turning to the reported accidents in factories, engineering works, &c., other than electrical generating-stations and sub-stations, there were 258 non-fatal and eight fatal accidents. This is an increase over the previous year, and is double the number of two years ago. The increase, Mr. Ram suggests, is probably due to the extended use of electrical energy in factories, and possibly more attention has been paid by occupiers to the necessity of reporting accidents under the Notices of Accidents Act, 1906. There is little, if anything, new as to the circumstances of the accidents; but, among other things, they show that regulating precautions are all too frequently ignored.

One of the fatalities particularly shows how essential it is that insulated wires should be properly protected; and this is a case that should receive the attention of those gas engineers in whose works electricity is found the most convenient method of driving for their particular purposes. In the case under notice, the insulation of the conductor was cut through by the edge of a piece of iron which a man was carrying; and although the pressure was only 250 volts alternating current, the man was killed. Another fatality occurred through a man touching with an iron rod the framing of an arc lamp working at high pressure; the frame of the lamp forming part of the circuit. It does not appear that the danger of electrical shock at low pressures is sufficiently realized. The term "low pressure" with many people seems to imply an absence of danger; and precautions are consequently not infrequently overlooked. As illustrating the dangers of low pressures, and also as indicating that the danger with alternating current is greater than with continuous current, a summary of the tables that have been published in the reports of the Chief Inspector for the six years from 1902 shows that there have been three fatalities from continuous current and 22 from alternating current at 250 volts or less, and 11 in addition from three-phase systems not exceeding 440 volts per phase, where the shock being to earth probably did not exceed 250 volts and in some cases was less than 200 volts. Of these 36 fatalities, 24 were on premises under the Factory Act. The report also directs attention to the danger of the use of hand electric lamps as ordinarily constructed. This danger is seldom realized; but Mr. Ram points out that it can be very easily guarded against. He illustrates defective hand lamps which have caused accidents; and he also describes a hand lamp of safe construction.

Reference is made in the report to the increase in the use of electricity for power purposes; the figures quoted having been compiled from the useful tables published by the "Electrician." The number of undertakings included in the returns for 1907 was 425; but 26 of the concerns, through false modesty or an inclination to secrecy, made no communication as to their power connections. But the 399 stations showed an aggregate connection of 357,000-horse power. Of the 399, no less than 148 have a connection of under 100-horse power apiece. For them the prospects of a good day load are grimly bad; and several of the other undertakings are not very much better off. The undertakings that have opportunities for a good power connection are comparatively few. The unequal distribution of the power business does not affect gas undertakings so much as electricity stations in view of the excellent gas cooking and heating load.

Speaking of power supply, and turning from Mr. Ram's report, reminds us of a table in the "West Ham Electrical Bulletin," headed "Cash Prices and Hiring Rates for Electric Motors." Looking down the figures, the inquirer for information is struck by the fact that cheap electricity for motive purposes is not everything, that there is something of rather substantial amount to be added (if motors are not purchased outright) for motor hire, the amounts of which hire suggest rather short lives for the motors, and not inconsiderable items for wear and tear. Take a few instances. For a ½-horse power motor—costing, inclusive of the pulley, starter, slide-rails, &c., £20—a rental of £4 a year is demanded; for a 1-horse power motor, costing £23, a rental of £5 per annum is asked; for a 5-horse power motor, costing £50, a rental of £8 a year is requested; for a 10-horse power motor, costing £60, a rental of £9 10s. is demanded; for a 15-horse power motor, costing £70, a rental of £10 is asked; for a 20-horse power motor, costing £90, £13 rental is required; and for a 30-horse power one, costing £110, a rental of £15 10s. is charged. The Electricity Department of the West Ham Corporation show an earnest desire to get the cost of the motors back in rental in the space of from five to seven years. The department are not to be blamed for this; but it is a point for would-be users who are attracted by the published or the secretly communicated tariffs of the department for electricity for power purposes. It is noticed that the "Bulletin" does not say anything about the losses of the department on the trading in the past year; nor is it likely that the next issue of the "Bulletin" will contain a report of the proceedings at the yet incomplete inquiry into an application to the Local Government Board for sanction to a further loan.

The electrical press and the daily papers have not overlooked the fact that the Highways Committee of the London County Council have been giving consideration to the lighting of Westminster Bridge, which is at present illuminated partly by gas and partly by electricity. The Committee give expression to the opinion (which we very readily endorse) that the substitution of electric arc lamps for the "existing gas-lamps" would be a great improvement, and add largely to the general illumination of the bridge. It will be noticed that the report says the "existing gas-lamps;" and as the existing gas-lamps contain flat-flame burners, there is no question as to the Committee being safe in their declaration. But why did the Committee stop at electric arc lamps as alternatives to the existing gas lighting; and, if better illumination and economy were the only things required, why did they not recommend the high-pressure system of gas lighting? It would have enabled them to supplant the electric arc lamps, to give a better illumination over the whole bridge, and at a cheaper rate than that at which the Highways Committee estimate the cost of electric arc lamps. Already electricity has the lion's share in the lighting of this bridge, though not of others across the Thames. The total annual cost under present conditions is £512, split up between electric lighting and gas lighting in the proportions of £336 and £176 respectively. The estimated annual cost of lighting the bridge under the scheme of the Committee is £436, or a saving of £76 a year. There are high-pressure gas-mains up to Bridge Street; and the thought naturally occurs, Why is high-pressure gas lighting not to be adopted for the bridge? Inquiry elicits the information that, as a matter of fact, the Gaslight and Coke Company did submit a scheme for high-pressure gas-lamps, which would have cost £362 10s. a year; thus producing a saving of £73 10s. beyond that to be realized under the recommendation of the Committee (or £149 on the existing lighting), while affording double the present amount of illumination on the bridge. We believe that the installation of the high-pressure lighting would have been well covered by £180; but it may be doubted whether this sum will cover the initial cost of changing to electricity. To say the least, it is somewhat peculiar that the Highways Committee in their report have ignored reference to this alternative and economizing proposal. Perhaps a reason for this might be discovered (if the matter was probed a little) in a desire to get a larger load for the Council's own generating-station. We seem to remember some little disappointment suffered by those in charge of the station over the lighting of Waterloo Bridge, and perhaps Westminster Bridge is intended to be the solatium. But there is no reason at all why the Council's electricity undertaking should be favoured at the expense of the ratepayers. Such favouritism is not good local government; and experience bears witness to the fact that it is not conducive to economy.

The report of the Board of Trade on the applications for Electric Lighting Provisional Orders during 1907 has been issued; and there is not much to be said upon it. Of course, the number of such applications cannot continue for ever at high-water mark. The best districts for supply have been absorbed; and the authorities of areas less likely to be lucrative, profiting by the poor show made by concerns in analogous areas, are growing less enamoured of the idea of becoming the owners of a white elephant. During the past four years there has been a consistent drop in the number of Orders applied for; and last year only seventeen applications emanated from local authorities and ten from companies or persons, and a number of these were from existing undertakers. Only 23 Orders were granted by the Board, and this number was confirmed by Parliament. Four years previously the number confirmed was 57; and the three years since show a sliding down to 56, 48, and 23. So that the 23 is not half the number of even 1906. This is a striking difference, too, from 1899 to 1901, when the applications confirmed by Parliament were 89, 98, and 96. However, the total number of Orders confirmed by Parliament since 1883 has been 1036, of which 261 have since been revoked or have expired. Respecting last year's applications, a couple of Orders promoted to empower the transfer of existing powers did not satisfy the Board, who were suspicious as to the financial position of the transferees.

The electrical people cannot long keep their envious eyes off the prepayment business of gas undertakings. "Facts," we accept as true the remark from the "Electrician," "appear to confirm the statement that a most profitable connection has been built up with this class of consumer in most cities and towns." This is why at intervals electricians revive the idea of making a fresh essay to get hold of some of this profit. But, unfortunately for them, the capital expense of providing for the supply of electricity to such consumers is heavy; the revenue derived from the consumers is small, and smaller in the case of electricity

than it is of gas, seeing that the electricians cannot offer the working man such cheap means for cooking and boiling as the gas companies, and means that do not object to a little rough treatment without getting the sulks and refusing further service. The cause of the revival of the question just now is the coming of a fresh electric prepayment meter which has the merit of being cheaper than its precursors, albeit, judging from the illustrations in the electrical press, it seems to suffer from a complication of mechanism. The diagnosis from print, however, may be faulty; seeing that the list price of the new electrolytic meter is only 30s., subject. But nothing is said as to the veracity of an electricity meter that can be sold at such a price, nor as to its capacity for having cognizance of (say) the consumption of a single 30 Hefner unit metallic filament lamp. However, the meter, it is considered, removes the hitherto existing deterrent to the exploiting of the electricity business among the working classes. Of course, the same thing has been thought before; but the result has never deviated from precedent. The new meter has restrictions. It can only be used on direct-current systems. The coin required for its operation is a shilling. The workman, as a rule, prefers to deal in pennyworths; and he likes a pennyworth of the agent he uses for lighting to serve him through a decent number of hours. The meter is at present only made in one size; its capacity being 5 amperes. After all in praise of the meter has been said, it does not alter the situation much. If it reduces the cost of providing supply to the working man, the metallic filament lamp reduces the revenue to be obtained from him—that is, if he can afford metallic filaments. Unfortunately, too, the working man does not want motive power in his dwelling; and he cannot afford electrical radiators and cooking appliances, nor can the electricity undertaking run to the expense of providing him with them. When the principles of Socialism have spread further, and have borne fruit, then perhaps the working man will be able to afford these things. It is to be hoped our electrical contemporaries will not take the hint, and begin to preach the doctrines of Socialism, on the ground that therein is a possible tangible business factor for electricity concerns.

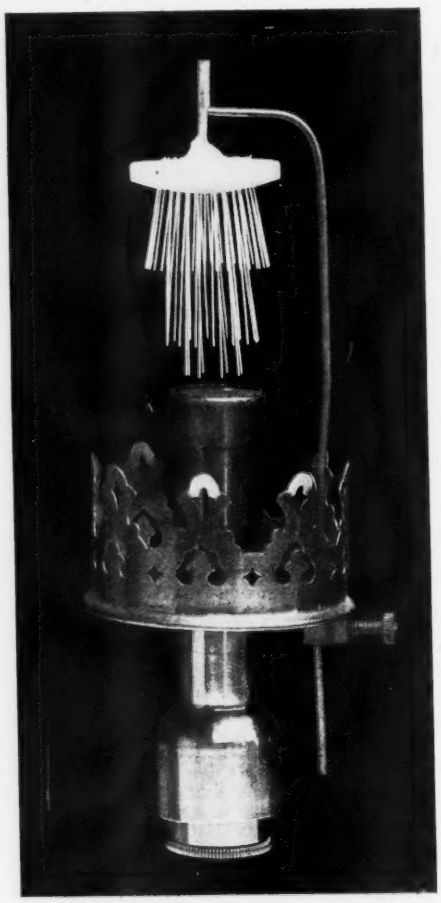
THE "HELLA BUSHLIGHT."

Rod Filaments for Incandescent Gas Lighting.

At the time of the issue of the prospectus some months ago of the Universal Gas Methane and "Buisson Hella" Company, Limited, a good deal of curiosity was aroused as to the precise nature of the incandescent lighting appliances which it was proposed to introduce to the notice of the British public, and which it was understood had been for some considerable period in use in Paris. Not very much information on this point was derivable from the prospectus itself; but at the subsequent statutory meeting, the Chairman of the Company (Mr. Randall H. Pye) stated that the apparatus would soon be on view in premises which had been secured for the purpose at No. 54, Cheapside, E.C. This show-room has lately been opened; and the Company's lighting speciality is now on view there, as well as in a pavilion in the grounds of the Franco-British Exhibition, so that those interested can ascertain for themselves the manner in which it is proposed to utilize rod filaments for incandescent lighting. In the window of the Cheapside premises, there is to be seen, among other things, a mechanical figure which dips one of the "buissons," or "bushes," into a glass of water, and then holds it over a bunsen burner, when it immediately becomes incandescent; this operation being continuously repeated, with the same result, and apparently without any injury whatever to the filaments. Close by, another "buisson" is fitted on a machine which imparts to it a rapid up-and-down motion, for the purpose of demonstrating its capacity to withstand vibration. These mechanical arrangements naturally secure a large amount of attention from passers-by; but being anxious to learn something more than is thereby shown as to the advantages claimed by the Company for the invention, a representative of the "Journal" last week interviewed Mr. C. F. Killar, one of the Directors, who furnished him with the following information in regard to the "Hella Bushlight," as it is now called (in place of the French term "buisson" which is embraced in the Company's title).

The accompanying illustration (which is about two-thirds of the size of the appliance) will perhaps convey a better idea of what the "Bushlight" is like than would any written description. In a disc of hardened fire-clay it will be seen that there are fitted in the form of a bush a number of filaments in the shape of rods or needles, having a thickness of 0·8 mm. and a length of from 25 to 30 mm. These filaments consist of thorium and cerium—the usual rare earths employed for incandescent lighting—mixed with a paste, which is then subjected in a furnace to a temperature of about 2000° C. The whole process really is based upon the paste employed, which is in accordance with a patent of M. Laigle, of Paris, as is also the manufacture of the filaments. An abstract of M. Laigle's patent specification for "Filaments for Incandescent Gas Mantles" was given in the "Journal" for June 16 last (p. 708); and the nature of the invention will be gathered from the opening sentences, which are as follows: "The invention relates to the production of infusible and indestructible gas-mantle filaments obtained by mixing certain oxides of the rare earths—such as those of thorium, cerium, and the like—with another more fusible oxide; and it consists in heating the filaments to, or slightly above, the melting point of the more fusible oxide, which, in the present case, acts as a binder—viz., berylla. The filament is obtained by forming a paste rendered plastic by the incorporation of the active principle of an agglutinant gum, which allows of a filament being easily made by means of a draw-plate (in the usual manner); the filament being subsequently heated to the temperature of the melting point of the binding oxide." The result is the production of a filament which is said to be practically indestructible by burning. The filaments are extremely brittle; but their strength is such that, if taken lengthways between the thumb and finger, an attempt to break one by pressure is likely to be a painful experiment. Instead of deteriorating by use, it is stated that the more they are burnt the better the results obtained from the filaments, because the more they become "baked" the more easily are they rendered incandescent—thus requiring less heat, and consequently less gas.

The burner designed for use with the filaments is made so as to turn the gas into the centre; and the "bush" itself does the spreading. Only one size bush is on view at present—the bijou, which is the size mostly used in France, where the bushes are being made pending the completion of the English factory—but it is intended to make larger ones, as well as patterns suitable



The "Hella Bushlight."

for use with inverted burners. The filaments can be made to give off various coloured lights—yellow, violet, blue, or red—by the introduction of certain oxides in their manufacture. This, it is anticipated, will be useful for decorative, photographic, and other purposes. Besides this, the bushes can be made to any design—such as in the form of stars or flowers; and in addition to gas, they are adaptable to use with other illuminants, like petrol, alcohol, and acetylene, in both fixed and portable lamps. Placed over a mixture of 80 per cent. of air and 20 per cent. of gas, the filaments become immediately incandescent; and it is maintained that the light given off is a more natural one than is obtained from ordinary incandescent mantles—being warm in tint and agreeable to the eye. The main advantages claimed by the Company for the "Hella Bushlight" are thus summarized: "It produces a better light than the best mantle made. It is perfectly rigid, and practically everlasting. It produces a light of uniform intensity. It is unaffected by draughts, wind, or rain."

With regard to the consumption of gas, this is said to be about the same as with an ordinary mantle of similar size; and as to the illuminating power, Dr. A. Berget, of Paris, reports that the luminous intensity of a bijou "Hella Bushlight" is 64½ candles, while the luminous intensity generally obtained from a comparable ordinary mantle is between 50 and 60 candles.

The Company have, as their title implies, acquired also another

process for use in connection with the gas industry—that is, the invention of M. Sabatier, for the manufacture of methane, which has already been fully described in our pages. Just now, however, attention is being mainly directed to the perfecting of arrangements for securing an adequate supply of English made bushes and burners for incandescent lighting. It is hoped that at no very distant date such a supply will be available; but just now only bushes and burners of French manufacture are on view.

REINFORCED CONCRETE PIPES AND POLES.

Readers of the "Journal" know the rapid and wide-spreading revolution which is being effected in all forms of construction by the employment of reinforced concrete. In their own sphere, they may remember that it has been employed by Mr. Harold W. Woodall for some of the buildings in the new works he has put up for the Bournemouth Gas and Water Company at Poole; and one of its latest applications is in the production of pipes for the conveyance of gas and water. Various attempts have been made to construct pipes and poles of concrete, either plain or reinforced; but difficulty has always been experienced in connection with their moulding—it having been customary to regard concrete as a material which must be cast. It is claimed that the difficulty has been removed by Herr Hans Siegwart, of Lucerne, who has invented a machine which obviates the use of external moulds, and automatically produces pipes for conveying gas, water, sewage, &c., under pressure, as well as hollow tapering poles or posts suitable for carrying wires for telegraph, electric light, or tramway purposes. The machine has been brought into this country by Messrs. Siegwart Limited, of Great Chapel Street, Westminster, who have installed it at the works of the Cubitt Concrete Construction Company, 260, Gray's Inn Road, where opportunity was afforded last week of seeing it in operation.

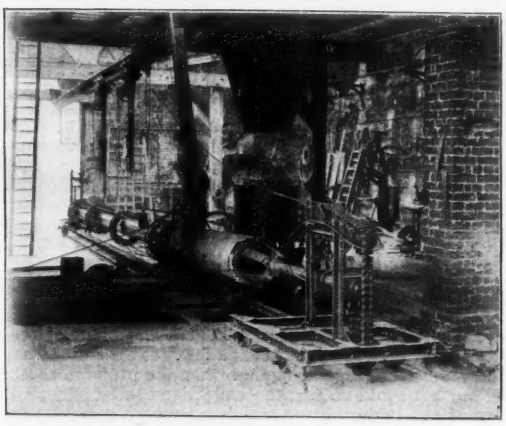


Fig. 1.

The above illustration shows the general arrangement of the machine. It will be seen that it rests in an open concrete pit sunk in the ground, with a track on either side, upon which trestles can be run, and a stage over the machine carrying a concrete mixer which discharges into a receptacle below on the machine itself. This mixer has paddle-wheels which rotate in an open box that can be tipped over to discharge its contents into the hopper below. These paddles thoroughly churn up the ingredients. The concrete used in the manufacture of poles and pipes is made of clean screened Thames grit, which mostly consists of sand, with occasionally small stones not larger than ½ inch maximum diameter, proportioned 3 to 1 of portland cement. The concrete is mixed very dry, so that it only feels moist to the hand, and does not even stick together when pressed. When discharged from the mixer into the hopper, the concrete falls into a sheet-metal drum, which in fig. 2 is shown standing at the back of the machine.

The process of manufacture is as follows: A long core of sheet iron is mounted on two trestles running on rails so as to be capable of rotation and longitudinal movement. Upon this core longitudinal steel rods of small size are fixed. The core is drawn through the machine, which is stationary. The concrete is discharged on to a bandage of coarse cloth webbing laid on a conveyor belt that takes one lap round the core. This continuous travelling conveyor belt is stretched so that it wraps the concrete round the core under great pressure. As the core issues beyond the conveyor belt, steel wire is fed spirally round it, so as to press into the concrete wrapping; and small rollers then apply great pressure by working on the webbing, the slack of which, produced by the reduction in circumference and external diameter resulting from this pressure, is taken up by another contrivance. The core, therefore, as it issues from the machine, is wrapped round spirally, with a bandage of cloth containing the concrete. The machine pulls the trestles with the suspended core regularly forward, so that the core passes through it as the concrete is wrapped round it. When the core has passed completely through the machine, it is lifted by an overhead travelling crane and placed on one side for the concrete to harden—this

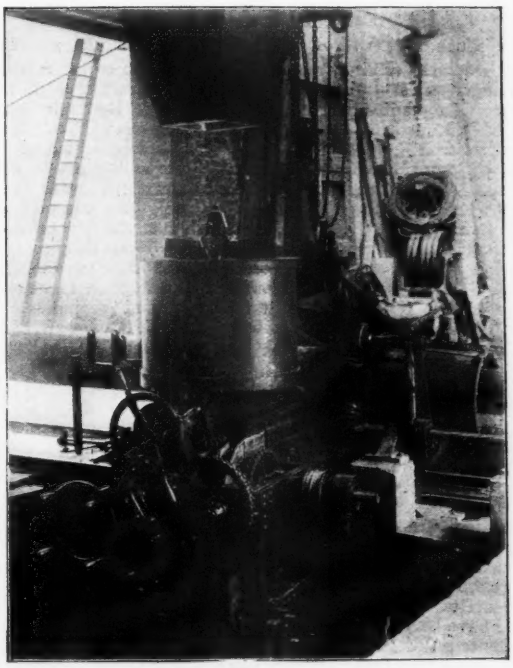
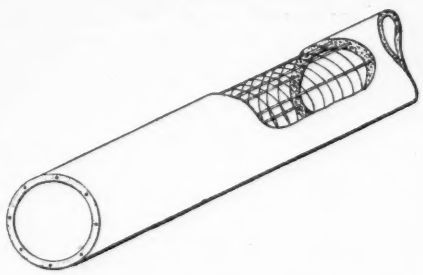


Fig. 2.

being constantly damped to ensure it gaining the maximum hardness. In about twelve hours the interior sheet-metal core is reduced in diameter by a screw attachment inside, and withdrawn from the pole. After hardening for about six days, the bandage of webbing is removed, and the pole is practically complete.



The above diagram shows the general arrangement of the reinforcement of a typical Siegwart pole. It will be seen that the reinforcing skeleton consists of longitudinal rods tied together by a wire or wires wound spirally thereon. It is important in such tubular construction to have the reinforcements correctly disposed; and it is claimed that the Siegwart process ensures every control over their position and accurate placing. In the ordinary process of moulding concrete in tubular form, grave defects in this respect are of common occurrence. It is extremely difficult to ensure regularity in the disposition of the reinforcements. The thickness of the concrete varies from 1 to 2 inches in poles, but from ¾ inch to 2 inches in pipes. A Siegwart pipe that has been tested, successfully resisted an internal hydraulic pressure of 285 lbs. per square inch. The pipes have a special joint for resisting pressure. Bitumen is filled in in the hollow spaces, and a short piece of pipe is passed over the joint and connected to the pipe with bitumen. It was such a joint that withstood a pressure of 285 lbs. per square inch. For ordinary pipes not called upon to sustain pressure, the jointing is by means of collars of reinforced concrete or sockets on the pipes.

The utility of the machine for the manufacture of pipes is of importance from an economic point of view. Iron pipes are expensive and subject to decay; whereas a reinforced concrete pipe on the Siegwart system is stated to be cheaper in first cost and immeasurably superior as regards durability, having a very long life. The steel, being embedded in the concrete, is entirely free from any danger of corrosion. The Siegwart pipes are made about twice the length of iron pipes, and are four times the length of cement or ordinary earthenware pipes; so that there is economy also in the laying, not only in respect to the jointing, but in the cutting of the trenches, for the width of the trench can be reduced to a minimum except at the point where the joint has to be made. It is submitted that the small number of joints ensures a main of Siegwart pipes being more reliable than one of iron pipes. Several other advantages in the way of resistance against fracture and of economy in transport, &c., are claimed for them.

THE LIGHTING OF AN ASYLUM.

Electrical Estimates.

THE "Visitors" of the Fulbourn Lunatic Asylum have had under consideration the lighting of the establishment; and they have been very easily persuaded into making a recommendation that electricity shall be used. The authorities concerned are the County Council of Cambridge, the Cambridge Borough Council, and the Council of the Isle of Ely; and they have all been asked to contribute their quota of the capital expenses. The County Council have already shown their willingness to be led without giving a thought as to whether or not there is another side to the tale that Mr. Graham Harris, who was consulted, has to tell. This gentleman is a member of the firm of Messrs. Bramwell and Harris, and he is an Electrical Engineer, and, consequently, it can hardly be imagined that he can bring to bear on his work such a sublime indifference to electrical interests that he can be said to be without prejudice. The County Council cannot exonerate themselves hereafter from liability for what they are doing by saying—as Mr. Webber, one of the members, said at the meeting the other day at which the Council swallowed the electricity scheme without very much thought—that "when they are advised by a man of Mr. Graham Harris's abilities, it was hardly for a layman to go behind that advice." The County Council are elected for the purpose of judicially examining all matters that come before them, and to examine them thoroughly, and not to accept, without the application of some amount of intelligence, all that men of "ability" tell them is true. A little common sense is useful among the members of a public body; and there are several passages in Mr. Graham Harris's report of which a common sense examination would have shown the Visitors Committee of the Lunatic Asylum that there were matters not specifically mentioned in the report that it would have been useful for them to have had under notice before coming to any determination. For instance, there is the point as to illumination. In Mr. Webber's remarks at the meeting of the County Council, he said that "he had personally asked Mr. Graham Harris whether 12,000 units was [*sic*] equivalent in lighting power to 3,000,000 cubic feet of gas; and he replied 'Yes, more.'" We shall be pleased to hear from Mr. Graham Harris that Mr. Webber entirely misunderstood him, or from Mr. Webber that he was incorrectly reported, because we flatly and deliberately say that the assertion contained in the statement is untrue.

In Mr. Graham Harris's report a sentence appears which supplies a basis for a ready calculation as to the candle power obtainable from 12,000 units under favourable conditions, and when voltages do not fluctuate. He says that a 16-candle power metallic filament lamp (which is a miserable light for any one point) consumes about 20 watts per hour. Therefore, a unit equalling 1000 watts, 12,000 units will equal 12,000,000 watts, which would keep 600,000 16-candle power lamps going for one hour, and give a total illuminating power of 600,000 × 16 = 9,600,000-candle power. It does not require an electrician, or a man of the shining ability of Mr. Graham Harris to make this calculation; even a "layman" can do it. If we take gas, an electrician of equal eminence and better known—Mr. James Swinburne—has said that he can photometrically obtain with the ordinary "C" incandescent gas-burner 18 candles per cubic foot of gas consumed per hour. The better incandescent burners will give 20 candles and upwards per cubic foot of gas consumed; the bijou inverted ones, burning only a little more than 1 cubic foot an hour, will give, approximately, 25 candles. But take the 18 candles attested by Mr. James Swinburne, 3,000,000 cubic feet, multiplied by 18 candles, represent 54,000,000 candles! Compare this with the 9,600,000 candles; then ask is it true that Mr. Graham Harris has said that "12,000 units of electricity is equivalent in lighting power to 3,000,000 cubic feet of gas, and more?"

There are many other questions involved in the lighting of the Asylum than that of the more economical illuminant—such as the initial capital outlay and annual capital charges. They should not be overlooked in the discussion of the matter by the authorities concerned; but we need not deal with them here. They can be handled by "laymen" easily enough if they will exert themselves a little. Nor need we notice the fixed charges proposed by the Cambridge Gaslight Company and the Electric Company respectively for gas main and electricity cable for supplying the Asylum under their schemes. The Gas Company tendered for a minimum consumption of 3 million cubic feet of gas at a cost of £329 7s. 6d. Now supposing all this gas was to be used for lighting purposes, and that 800 incandescent gas-lamps were required to be kept alight at the same time. The 3 million cubic feet of gas would allow each incandescent lamp a consumption of 3750 cubic feet per annum; and if the lamps were such as would burn 3 cubic feet an hour, this amount of gas would permit of 1250 hours' use of every lamp. Reckoning 18 candles per cubic foot, each lamp would give 54 candles (not the poor light of 16 candles), or an aggregate illuminating power about the building with the 800 lamps of 43,200 candles. If 900 16-candle power electric lamps are used, there will only be a light about the building of 14,400 candles at any one time, or exactly one-third the amount of illumination that would be given by the 800 incandescent gas-lamps. Is this miserable light advantageous for a great and important building such as the Asylum?

Look at the matter another way. If 900 16-candle power electric lamps were alight at once at 20 watts per lamp each, the total consumption would be 18 units an hour. If the lamps were kept alight for the 1250 hours a year as reckoned above (for the sake of illustration) 22,500 units of electricity would be consumed—that is to say, 10,500 units beyond the 12,000 provided for. The 10,500 units at the 1½d. to be paid per unit beyond the 12,000 units would cost another £65 12s. 6d.; so that the electricity alone for 14,400 candle power over 1250 lighting hours would cost £265 12s. 6d., against the 43,200-candle power of gas at £63 15s. more. That is to say two-thirds more illumination are offered by incandescent gas lighting to the Asylum authorities for an additional payment of only £63 15s.

It is little use carrying the calculations further to see what additional lighting could be obtained by spending the £63 15s. difference on electricity, as the Electricity Company's offer is so hedged about with restrictions that no more than 20 units per hour can be used. The 20 units of electricity would only supply 1000 16-candle power lamps, and give a total illuminating power of 16,000 candles; and the electricity only for this candle power would cost £281 5s. a year for the 1250 hours' lighting, against the 43,200-candle power that could be realized by spending £329 7s. 6d. on gas.

Besides the great disparity between the illuminating power obtainable by the two agents, and the question of the miserable amount of light offered by the 16-candle power electric lamps, the authorities concerned are taking upon themselves a serious responsibility in introducing into an asylum a system of lighting that has a name for unreliability and other uncertainties. We hope the Cambridge Borough Council will set their faces sternly against the action of the Visitors Committee and the County Council, until there has been full and adequate consideration of the subject in all its bearings. Full and adequate consideration there has not been yet.

PERSONAL.

Mr. C. DIGGORY has been appointed Secretary of the Corwen Water Company, in succession to Mr. J. Williams, who recently resigned.

Mr. THOMAS H. BEAUMONT, who has been engaged for some years as Assistant to Mr. Edward A. Harman, M.Inst.C.E., the Engineer and Manager of the Huddersfield Corporation Gas-Works, has recently been appointed Manager of the Portland Gas-Works, to fill the vacancy caused by the resignation of Mr. J. Hansford.

Gas at the Franco-British Exhibition.

An example which is worthy of being followed has been set by the Croydon Gas Company, with the object of directing attention to the display of gas at the Franco-British Exhibition. The Secretary (Mr. W. W. Topley) has sent a letter to the laundries in the Company's district, suggesting that when the proprietor visits the Exhibition he should inspect the collective exhibit arranged by a number of gas undertakings, which comprises a special section dealing with laundry work. A similar letter has been sent to the bakers, to inform them that the exhibit of Messrs. Joseph Baker and Sons, Limited, in the Lower Crescent, includes several coke-fired ovens in actual operation, illustrating the advantages to be derived from the use of this fuel. The above-named firm will be pleased to show the working of the ovens in detail to any baker who may call on their representative there. Enclosed in each letter is a publication furnishing particulars of the matter specially mentioned, a ticket of admission to the Exhibition, and a sketch plan showing in red the location of the Gas Section, Messrs. Baker's exhibit, and the portions of the grounds lighted by the Keith high-pressure lamps, of which particulars have been given in the "JOURNAL." It may be hoped that both classes of consumers will avail themselves of the opportunity which the Company have afforded them of inspecting the exhibits in which they are specially interested.

South-East of Ireland Gas Association.—A quarterly meeting of the Association will be held next Monday in Dublin. There is no technical business to come before the members, who will dine together at the St. Lawrence Hotel, Howth Head. It is intended to proceed in the evening to Belfast, so as to allow of attendance at the meeting of the Irish Association at Holywood the following day.

Municipal Coal Supply.—At the meeting of the Leeds City Council last Wednesday, Mr. Badlay again brought forward his resolution in favour of the Corporation purchasing and working a coal pit or pits, and also trading in coal. In support of his proposal, he held out the prospect of a reduction in the rates of from 2s. to 3s. in the pound. The motion did not give rise to any discussion, and was defeated by 36 votes to 9. The subject of the municipal ownership of coal mines has been discussed for some months in the City Council of Vienna; and it is reported that the Council are now trying to secure control of mines in Moravia. The reasons given for the purchase are the high price of coal, and the difficulty of securing a steady supply for the municipal gas and electricity plants.

THE NORTH BRITISH ASSOCIATION OF GAS MANAGERS.

Annual Meeting in Edinburgh.

We complete to-day our report of the proceedings, on the 23rd ult., at the annual meeting of the North British Association, in Edinburgh, by giving the two papers dealing with high-pressure gas distribution, and the discussion to which they gave rise.

HIGH-PRESSURE DISTRIBUTION.

By James D. Keillor, of Lochgelly.

The town of Lochgelly is right in the heart of the Fife coal-fields, and adjacent villages are Glencraig, Crosshill, and Lochore. The district is growing at an extraordinary rate; so much so that all these villages are linked to the town of Lochgelly by streets of buildings. The distance from the gas-works to the most outlying village is about 2¼ miles. In 1906 the population of these villages was 2900; to-day it is estimated to be 5400. In consequence of the rapid growth of the district and the increasing demand for gas, it was found necessary about a year-and-a-half ago to prepare a scheme for the entire enlargement and re-modelling of the gas-works. The scheme is now about completed; and the results to date are most gratifying. During the year 1906, the annual make of gas was 10 million cubic feet; last year it was 18 millions—an increase of 80 per cent. It is interesting to state that since the beginning of the present financial year the increase in output, compared with last year, is at the rate of 60 per cent.

The growth of the district being so rapid and till a year or two ago quite unlooked for, it was only to be expected that the distribution system would also require to be enlarged and extended. In 1905 (prior to my appointment to Lochgelly), 1¼ miles of 4-inch main pipe had been laid to supply the demands of Glencraig and Crosshill villages. In May, 1906, when I took over the control of affairs, the number of consumers in these villages was only 52; and the total consumption of gas 180,000 cubic feet. I ascertained further that the number of houses in this district not "gas fitted" was 300, and that new houses were being thrown up by the "street" and actually let long before they were ready for occupation. So much untapped property had only one meaning to my mind—viz., increased prosperity to the Company I served. By May, 1907, the number of consumers in the district had increased to 142, and the gas consumption to 540,000 cubic feet; and at May last, the consumers had further increased to 800, and the gas consumption to over 2,000,000 cubic feet. During the autumn of 1907 the main pipe was extended to Lochore, and immediately 200 additional consumers were obtained. About the same time it was arranged with all the proprietors of property in Glencraig and Crosshill to fit up every house in both villages with suitable gas-fittings. To meet this, the Gas Company decided to lay about two miles of new branch mains; and, incidentally, I may add, the Company carried out, under contract, the entire gas-fitting of all un-gasfitted houses in the district.

It was early realized that the existing 4-inch trunk-main would be insufficient to supply all these new and additional consumers. Therefore the laying of branch mains, and consequently the supply of fully 300 consumers, was temporarily suspended until the whole question of the distributory system was discussed by the Directors of the Company. There were only two ways out of the difficulty. The first was to lay a large new low-pressure main from the gas-works to a point fully two miles distant, substituting the existing 4-inch main; the other was to introduce a system of high-pressure distribution suitably governed to the requirements of consumers. I carefully considered the costs and possibilities of both methods, and decided to recommend a system of high-pressure distribution. The Directors approved; and I forthwith made arrangements to instal the necessary apparatus.

In a district like ours, which had outgrown the distributory mains, there is very great economy in introducing a system of high-pressure distribution. It was calculated that about two miles of 7-inch low-pressure leading main would be necessary for an efficient supply to the district; and at the end of this low-pressure main, it was required to deliver 6000 cubic feet per hour with a maximum works' pressure of 3 inches.

The cost of this new low-pressure main, with all necessary branch and service connections, was estimated at	£1480 0 0
The cost of the pressure-raising and distributory scheme complete, including gas-engines and blowers (in duplicate), foundations and pipe connections, governors, fixing governors, and testing mains and house-fittings prior to the high-pressure supply, was	422 10 0
Showing a comparative first-cost saving between the systems of	£1057 10 0
There was a further saving effected in the laying of all new and additional branch mains, because it was found possible to lay smaller branch mains than could have been laid down for a low-pressure system. This saving amounted to, in round figures	282 0 0
Total saving effected	£1339 10 0

These figures show a very great saving in favour of high-pressure distribution compared with the first cost of new and enlarged low-pressure mains for one district only. When we couple-up another district to the same compressors, the saving will be proportionately greater. Of course, it should be noted that the rate of depreciation and maintenance will be higher in comparison, and there will be the cost of gas for running the compressors. But, if we take into account the fact that we have now a system which can be applied to the entire town and surrounding district, and that private consumers and manufacturers have the advantage of high-pressure gas if it is desired, then I think it is something not only to conjure with, but something real and tangible for the credit side of the balance-sheet. After five months' experience, we have found the gas-engines and compressors require no more attention than an ordinary gas-exhauster; and if this is any indication of future wear and tear, the probability is that the maintenance charges for the whole system will be very low.

After deciding to adopt a system of high-pressure gas supply, I considered it advisable to make first a systematic test of all the mains and services and house fittings in the districts to be supplied prior to the high-pressure system being inaugurated. All interior house-fittings were tested up to 15 inches air pressure; and, as expected, numerous trifling defects were discovered and rectified. The 4-inch existing main was tested in sections of 500 yards—rack-and-pinion valves being permanently fixed with ½-inch upright pipes on either side of the valve for testing purposes.

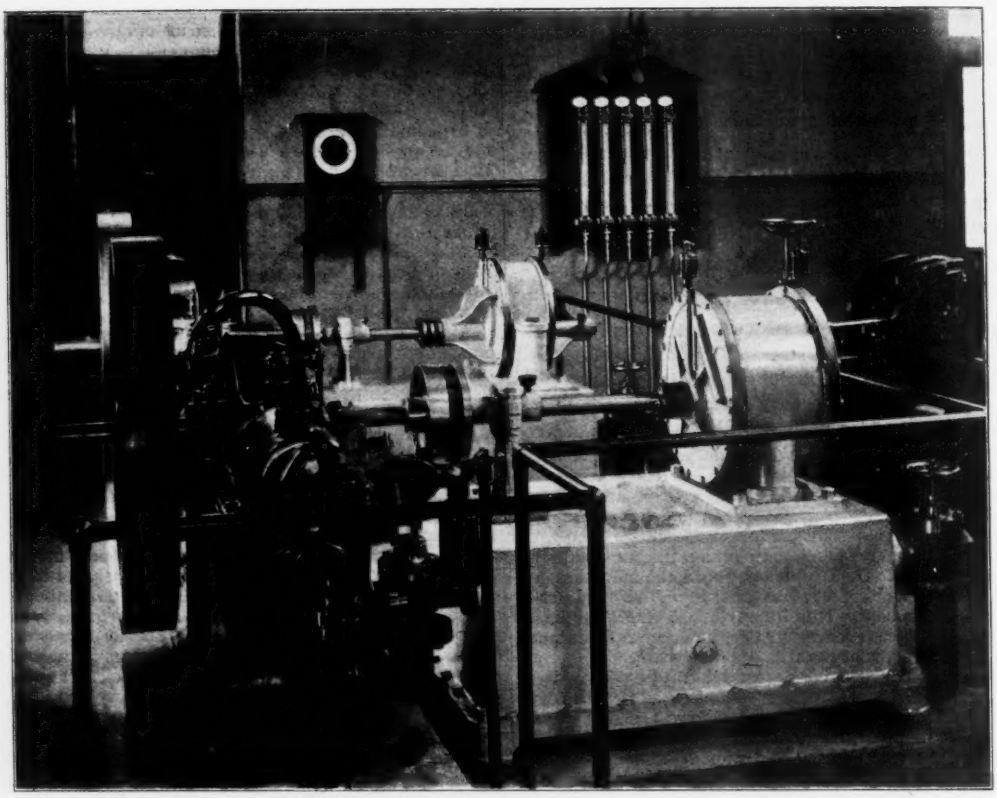
These valves and test pipes are easy of access, and can be got at through a manhole cover at the street-level. The main and services were tested up to 20 inches air pressure; and I was agreeably surprised to find so few trifling escapes over the length of 4-inch cast-iron main pipe. The greatest number of leaks was found in the service-pipe system, and the majority on the lead-pipe services. Every service in the district was overhauled and renewed where necessary. All service pipes are now of malleable-iron tube, steam quality, painted. This examination gave us a good deal of trouble; but I am satisfied the expense incurred has been already well repaid. Now that the valves are in suitable positions, we can at any time test the soundness of the entire high-pressure district, which is divided and subdivided into sections and sub-sections. A test of any section can be accomplished in a few minutes by closing two valves and applying a suitable pressure gauge. When a test is being made it in no way inconveniences the consumers in front or beyond the section under test, because the high pressure in the mains is always sufficient to supply ordinary daylight wants for a much longer period than the period of test. The pressure gauge used is an ordinary V tube gauge filled with mercury. The reading indicated, multiplied by 13·8, gives the pressure in inches of water.

It is not my intention to weary you with the preliminary thought and consideration that I devoted to this subject prior to my ultimate decision to adopt a plant capable of meeting all our requirements. Suffice it to say that all known systems of high-pressure distribution and supply were examined and considered; but, compared with the simple and effective American system, all other systems were, to my mind, either deficient or too complicated and costly. Owing to the great variations in level throughout the district of proposed high-pressure supply, it was difficult to calculate the pressure required at the works to give a certain pressure during the peak-load at the extreme end of our district; but, by verifying calculations by every known authority and method, it was found that, using a 4-inch main, 70 inches water pressure at the works was necessary to maintain a pressure of 3 inches of water at the outskirts of the district, 2¼ miles distant. However, as the system of compression and distribution to be adopted was capable of supplying gas up to 5 lbs. per square inch—this being equal to 138·40 inches of water pressure—these previously-made calculations were left to be verified by practice. As a matter of fact, we can at present easily maintain 8 inches of pressure during the peak-load with a maximum of 60 inches at the works; the blowers passing 3000 cubic feet per hour.

The type of pressure-raiser to be installed at Lochgelly claimed most of the author's attention. There are numerous types on the market; and difficulty was experienced in making a selection. Each type had its advantages and disadvantages. The ordinary fan and rotary exhauster type employed for boosting purposes was considered useless for our purpose, as they could only be used with a complicated system of governors, anti-fluctuators, &c. To my mind, too much automaticism is always a mistake, and should be rigorously avoided. The positive rotary blower, as made by the Keith and Blackman Company, of London, was, by reason of its simplicity and compactness, and because of its success in private installations, considered the safest and most reliable plant for our purpose. A duplicate set of this type of pressure-raiser, each capable of delivering 8000 cubic feet per hour, and raising the initial pressure to 5 lbs. per square inch, was therefore duly installed. The blower proper is of the eccentric drum type, being fitted with four blades.

Several novel features have been introduced in the design. The blades are made hollow, and are well stayed between the surfaces, so as to reduce the centrifugal effect as far as possible. But, in order to reduce the pressure of the blades on the outer casing, they are so arranged that the opposite blades almost completely balance each other. This is accomplished by using a pair of floating rings, one at each end of the cylinder, which revolve with the blades and eccentric drum, but in a position concentric with the outer cylinder.

At the inner ends, on each side of the blades, are fixed horizontal pins, each covered with gun-metal blocks. The outer



Interior of th Gas Compressor House at Lochgelly.

edges of these blocks bear on the inner edges of the aforementioned rings; and in this way the blades are limited in the extent to which they can fly out by centrifugal force, and they thus also balance each other. The inner edges of the blocks bear upon discs fixed concentric with the outer cylinder, and merely act as a guide for the path of the blades. Therefore the considerable frictional loss which usually accompanies this class of blower is overcome. A very common method of preventing the blades flying out is to have similar blocks running in grooves in the cylinder covers, concentric with the outer cylinder. The difference between the two methods is that in the case of the groove, the pressure exerted by the centrifugal force of the blades is transmitted by the blocks to the surface of the grooves, and considerable friction is set up between the rapidly revolving blocks and the groove.

With the above-mentioned method, however, the pressure is transmitted in the same way to the inner surface of the floating ring; but as the ring revolves with the blocks, there is only a very slight slip-action throughout each revolution, which is brought about by the difference of centres between the drum and the ring. The outer edges of the blades are fitted with gun-metal strips, which are capable of slipping outwards, and so pressing on the outer cylinders. For pressures up to (say) 2 lbs. per square inch, the centrifugal effect of these loose strips is sufficient to keep them quite tight, and, for higher pressures, light springs are fitted behind them.

The ends of the eccentric drum, which is usually the greatest source of leakage in this type of blower, are made tight by means of a split piston ring of the same diameter as the drum, which is let into one of the cylinder covers, and kept pressed against the end of the drum by flat springs distributed around the groove, which prevent it revolving with the drum. This automatically takes up any end-wear, and allows for expansion.

The covers of the blower are so jointed to the cylinder that they are always screwed up metal to metal, so as to preserve the correct end measurement between them, which is a very important matter. This is accomplished by turning grooves in the flange of the cylinder and inserting therein a soft packing, which is left a little proud. When the cover is bolted up, this packing makes a sufficiently tight joint, which can be broken as often as desired without destroying the packing. In order to prevent high pressure at any time coming on to the gland, a port is led from an annular groove around the same to the low-pressure side of the blower.

To overcome the pulsating effect which is very common with this type of blower when working against a high pressure, an auxiliary port is formed in one of the covers leading from the high pressure to a point between the blades, so as to feed the space between with high pressure before this space reaches the discharge port. As there is no actual compression given to the gas before the space between the blades reaches the discharge port, it will be easily seen that, when this space is suddenly opened to the high pressure, there is a rush of high-pressure gas into it until the pressure is equalized, which is apt to cause a distinct pulsation as each blade passes the discharge port. By feeding the space between the blades in the manner described, this difficulty is avoided without any loss of efficiency.

The blower is mounted on to a cast-iron box-base, which is divided into two portions—one connected to the low-pressure and the other to the high-pressure supply; and the inlet and outlet of the blower are directly connected with these respectively. In a partition between the high-pressure and the low-pressure portion is fixed the automatic regulating valve, which controls the pressure at which the blower delivers the gas. This consists of a special form of safety valve with an enlarged spindle, which works in an oil dash-pot.

The body of the valve is so arranged as to offer the least possible resistance to the flow of the gas which passes through it. The valves can be loaded by means of dead-weights to give the exact pressure desired, and all surplus gas is discharged from the high-pressure to the low-pressure side. In this way, so long as the capacity of the blower is not exceeded, a constant pressure is maintained, no matter whether the full capacity is being used or the outlet entirely shut off. The pressure thus never rises higher than the valve may be weighted to give.

The oil dash-pot plays a very important part in the efficient working of this valve, as without some such arrangement a dancing motion would be set up in the valve. The oil dash-pot is arranged so that it may be charged with oil from outside the box; a connection being carried through the side, fitted with a filler and screw-plug. By this means the oil can be added, and in case of the oil already in becoming dirty or thick, it can be washed out and replaced with fresh oil without having to open-up the compressor. A manhole door is provided on the side of the base to permit of the valve being examined and adjusted for pressure. An important feature of the valve is that it cannot be readily tampered with, as before the pressure can be interfered with, the door must be removed. There are no stuffing-boxes to leak or become stiff, and the valve, although extremely simple, has been found in practice to give admirable results.

The blowers are driven by a separate 5 B.H.P. Gardner gas-engine coupled direct, and will run at 200 revolutions a minute when the blowers are delivering their maximum quantity. They, however, can be arranged to be driven direct by an electric motor or by belt.

The lubrication of the blower is accomplished by gas-tight sight-feed lubricators. These are arranged to admit oil to the main-bearings on each side of the cylinder, and prevent the oil being carried by centrifugal force to all parts of the blower. Any surplus oil is discharged into the box-base, and may be drawn off by a plug provided for the purpose.

The arrangement of blowers and connections is such that the inlet and outlet pipes are common to both machines. Between the inlet and outlet mains there is a safety bye-pass arrangement. This is simply an ordinary 4-inch self-acting bye-pass valve, with the flap specially weighted to open with an inlet pressure of 3 inches. When the blowers are started, the increased pressure on the outlet automatically closes the flap, and when the blower

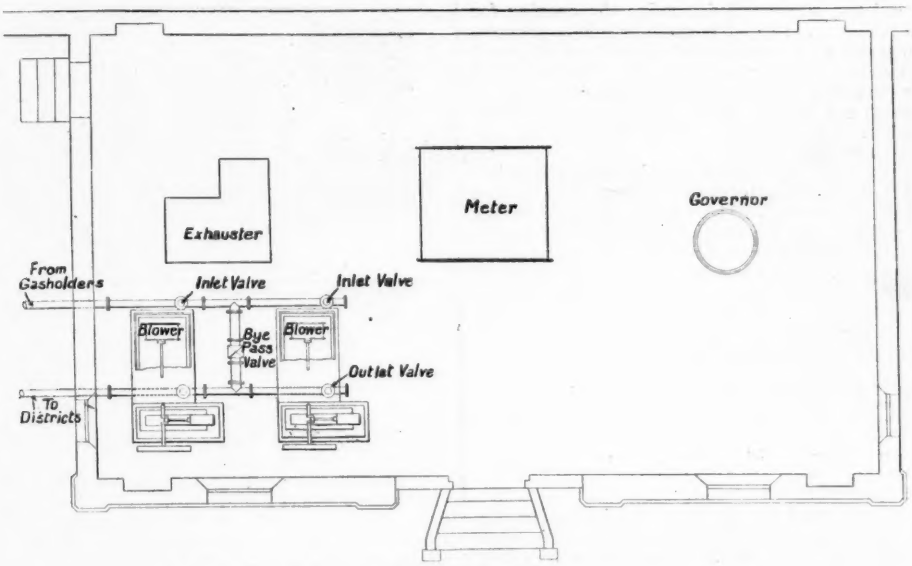


Fig. 1.—Plan of the Exhauster, Meter, Governor, and Compressor House.

is stopped, by design or otherwise, the flap-valve automatically opens whenever the high pressure in the main supplying the district falls below the pressure thrown by the gasholders. The bye-pass valve is fitted with a knocker, so that in case of emergency it can be easily and quickly opened or shut by hand. This is the only automatic arrangement attached to our system, which is the very essence of simplicity, serves our purpose admirably, and never fails to act when the blower is started or shut down. In this way a total cessation of the gas supply to the high-pressure district is absolutely impossible.

The two blowers, with engines, only occupy a space of 7 feet by 5 feet each; and they are housed under the same roof as the exhausters, station meter, and governor (see fig. 1).

Each blower runs week by week alternately. After a week's run, the gas-engine is thoroughly cleaned and made ready for the following week. At present we only run as the hours of minimum consumption merge into those of maximum demand, and stop at midnight. The day consumption does not yet demand anything beyond the 3-inch pressure thrown by the gasholders.

The blowers are started-up by setting the gas-engine in motion, and, when once set agoing, require no more attention than is usually given to an ordinary type of gas-exhauster. Meantime the blowers run at a speed of 100 revolutions per minute; the gasholder pressure of 3 inches being raised to 60 inches water pressure at the outlet of the blower. This pressure, which is a little more than is necessary to meet the present demand during the peak-load, is passed directly into the 4-inch main, and thence to the consumer. No compression storage tanks are used meantime either at the works or in the district supplied, the size of the mains being of sufficient capacity to store under 60 inches water pressure nearly half-an-hour's maximum consumption of gas. Thus, in the event of a breakdown, causing one blower to be thrown out of action, and until the duplicate blower is started, consumers will not be inconvenienced.

The compressors during the present maximum hours are dealing with about 3000 cubic feet of gas per hour; and each gas-engine, running at 100 revolutions per minute, has been proved, after numerous tests, to consume gas at the rate of 15 cubic feet per brake-horse-power per hour—equal to 75 cubic feet of gas per hour. Taking the cost of gas at 2s. 6d. per 1000 cubic feet, and the present output of the machines, the cost of compression to 2·25 lbs. per square inch is equal to 0·75d. per 1000 cubic feet of gas delivered.

It is not possible, as yet, to give a figure for maintenance charges; but, as indicated elsewhere, these charges will be very low indeed.

Wherever a boosting system is employed on a main which has a varying consumption, or in any system of direct high-pressure distribution, one of the most important matters is the provision of a simple and reliable governor for the purpose of reducing the pressure to the extent necessary for measurement and combustion by ordinary appliances. Not only the services taken direct off the high-pressure main, but also the end of the high-pressure main itself, must be governed if there is any large consumption at the terminus. For it is evident that, with an initial pressure of (say) 60 inches at the boosting apparatus to supply the maximum demand at the end of the main, the pressure will gradually increase at the end of the main as the consumption falls off, until, if there were no consumption at all, the pressure at the end of the main would be the same as the initial pressure at the booster, supposing the main to be on a level. Lochore is fully 2¼ miles from our works. The altitude of the village is about 60 feet above the level of the gas-works, and situated practically at the end of our 4-inch high-pressure main. At a point near where the branch mains radiate to supply the village, one large district high-pressure mercurial governor is fixed on the high-pressure main, thus governing the supply to the entire village of about 300 consumers. All the way from the gas-works to where this governor is fixed, consumers are taken off, and branch mains radiate to various points on both sides of the feeding main. Each consumer's service, taken directly off the 4-inch trunk mains and smaller side mains, is governed by a separate service governor.

The pressure at the inlet side of the large district governor referred to above varies, according to the draw upon the main during the peak-load, from 6 to 18 inches.

The following table is a record of the average pressure indicated at a point three-quarters of a mile from the works where the main is 150 feet below the level of the works, and at the end of the main, where the district governor is fixed, which is 60 feet above the level of the works:—

Record of Pressure on Main.

Time.	Pressure at Works.	At a Point ¾ Mile from the Works.	At a Point where District Governor is Fixed 2¼ Miles Distant.
7 p.m. (dusk)	60 inches {compressor started}	60 inches	60 inches
8.30 ,, (dark)	60 ,,	52 ,,	32 ,,
9 ,,	60 ,,	39 ,,	16 ,,
9.30 ,,	60 ,,	34 ,,	12 ,,
10 ,,	60 ,,	30 ,,	8 ,,
10.30 ,,	60 ,,	29 ,,	8 ,,
11 ,,	60 ,,	38 ,,	17 ,,
11.30 ,,	60 ,,	49 ,,	26 ,,
12 a.m.	60 ,,	58 ,,	51 ,,
12.15 ,,	60 ,, {compressor stopped}	60 ,,	59 ,,

District High-Pressure Mercurial Governor.

The high-pressure district governor in use was specially designed and manufactured for us by Messrs. J. Milne and Son, Limited, of Edinburgh; the object being, as previously mentioned, for reducing the high pressure at the point of distribution to the ordinary town pressure for consumers. This governor is constructed for an inlet pressure of 5 lbs. per square inch and an outlet pressure of zero to 6 inches; but, of course, it could also be made to suit any other pressure which may be desired.

With any system of governing, where the inlet pressure is great, it is necessary that the governors should be fully and accurately compensated, so that any variation of the inlet pressure to the governor will not cause the slightest oscillation on the outlet or consumer's side. This is provided for in Milne's governor by the adoption of an inner bell of the same diameter as the face of the governor valve. The inlet pressure is acting on an equal area in an upward direction inside the roof of the bell, and at the same time in a downward direction on the face of the valve. Any variation of inlet pressure is thereby compensated. This compensation is so accurately adjusted that the governor can be used as an ordinary low-pressure governor, provided that the inlet pressure exceeds the outlet pressure by not less than 5-10ths; and, in the event of the high-pressure main being used for a period as an ordinary low-pressure main, the governor will still act and regulate the pressure.

The action of the governor is as follows: Without the weights, the bell will remain in the bottom position with the valve open. As the outlet pressure is raised, the gas will pass through the inlet and act on the annular area at the top of the bell and close the valve. The amount of opening is then regulated by the

addition of the weights, which will determine the opening for any desired outlet pressure. The bell is made as light as possible, and its weight, together with that of the valve and spindle, must be less than the minimum outlet pressure, so that the first weight added will bring the outlet pressure up to the minimum pressure required, after which any other pressure desired can be got by adding other weights. The bells are of the finest black charcoal iron, which is not affected by the mercury.

To prevent leakage of the mercury, the tanks are made in two pieces and accurately machined to ensure a close joint without the use of any jointing material. The annular spaces, in which the bells move, and which also contain the mercury for sealing them, are made as small as practicable, so as to reduce as far as possible the quantity of mercury required. But ample space is provided to allow of the free movement of the bells without friction against the sides of the spaces. The bells are also centrally guided by the valve spindle for the purpose of eliminating friction as far as possible. This governor is capable of passing—

2500	cubic feet	per hour	at 3	inches	water pressure.
3600	,,	,,	6	,,	,,
4900	,,	,,	12	,,	,,
6600	,,	,,	25	,,	,,
9400	,,	,,	50	,,	,,

Service Governor.

The service governor used for the purpose of reducing the pressure is of the diaphragm type, manufactured specially for us by the Keith and Blackman Company. For small consumptions, the diaphragm governor is found to be the most convenient. The diaphragms are made from selected meter skins, and control the admission of high-pressure gas by means of a lever acting on a leather-faced valve.

The effect of the diaphragm is only to open the valve when the pressure falls below the actual pressure it is set to supply; the valve being shut by a spring as soon as the high pressure operates on the diaphragm. This gives a very simple and efficient arrangement, and one of the chief advantages is that the valve can be readily removed for examination without disturbing any other portion of the governor. The main load is given by a flat weight fixed on the top of the diaphragm, which gives a distributed pressure. This weight is supplemented by a tension spring on the underside of the diaphragm, and, by reducing or increasing the tension of the spring, the valve can be adjusted to increase or decrease the pressure as desired. This adjustment is effected by removing a plug; and, as the whole may be sealed up, it cannot be readily tampered with. The top cover of the diaphragm is fitted with a connection, to which it is advisable to fit a small vent tube. This tube should be carried to the exterior of the premises in case of any foul air arising from the working of the diaphragm. In order to prevent the vibration or dancing of the diaphragm, a small hole is made through the connection into the space above the diaphragm.

As common with other types of reducing valves, there is always the risk of the gas-reducing valves going wrong, and the pressure increasing beyond the set maximum. In the ordinary way, this would do no harm; but in towns and houses where water-slide fittings are in use, the water-slides would blow. To obviate any possible trouble of this sort, a safety device or mercury seal would be required to be fixed with the governor.

In Lochgelly, however, we have no water-slide fittings in use; therefore no safety device beyond the provision of a specially made high-pressure gas-cock, which is fixed to the inlet of the governor, is required. The consumer has special instructions to close this cock immediately anything unusual occurs to disturb his peace of mind, So far, however, not a single complaint has been registered regarding the working of the governor.

With few exceptions, the governors are fixed close to the consumers' meters, and in a few cases the governors are fixed just outside the premises under cover of an ordinary street surface-box. Each governor is adjusted to give 2½ inches water pressure on the outlet, irrespective of any variations on the inlet. The governors in use vary in size from ½ inch to 1 inch. The governors were all very carefully tested at pressures varying from 12 inches water pressure upwards. The quantity of gas passed by these governors at 12 inches water pressure is as follows:—

½-inch	governor,	50	cubic feet	per hour.
¾-inch	,,	100	,,	,,
1-inch	,,	150	,,	,,

When it can be arranged, we do not fix a separate governor on each service. As we had the mains and service pipes to lay after the pressure plant was selected, the mains and services were arranged accordingly.

Most of the property in Lochgelly is built in rows of from six to twenty-four houses. In such cases, we make one governor suffice. The governor is fitted in a convenient and suitable place, easy of access. The pipe from the outlet of the governors is increased to one size larger than the actual outlet size of the governor. This is particularly desirable where there is a fair length of service, and also on account of the pipes being underground. This supply pipe acts as a low-pressure service for any particular block

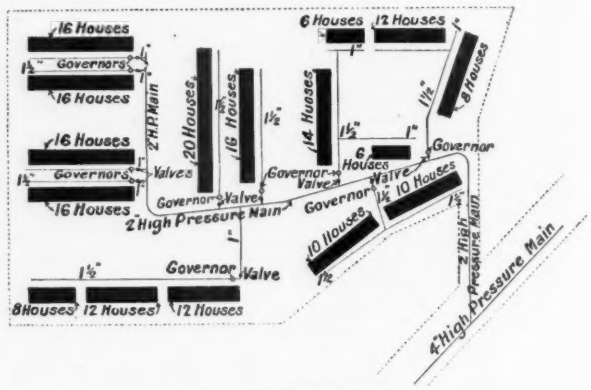


Fig. 2.—System of Governing.

of buildings. The houses are then connected to the low-pressure service as shown in fig. 2.

With regard to service pipes connected direct to the high-pressure mains, nothing larger or smaller than ½-inch pipe is used for ordinary three and four roomed cottages and shops. The main is bored and tapped in the ordinary way—in daytime, of course, when the entire system is under low pressure. A hexagon nipple is first inserted, then a specially heavy high-pressure cock is fixed, from which the pipe is run to a cock attached to the inlet of the governor (see fig. 3).

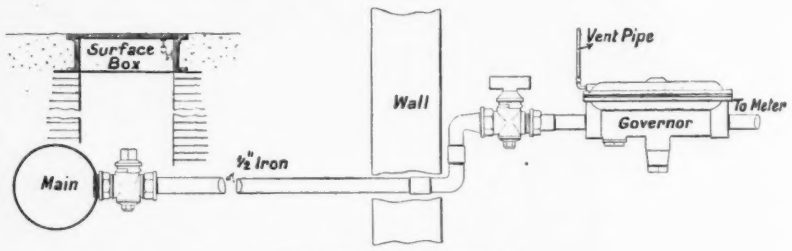


Fig. 3.—Service Connection.

The district supplied by high pressure is now fed by 2¼ miles of 4-inch trunk main; 2½ miles of branch mains, varying in bore from ¾ inch to 3 inches; and 3 miles of service pipes, varying in bore from ½ inch to 1 inch. Of this, 2200 yards is 4-inch cast-iron main, 1760 yards is 4-inch Mannesmann steel tubes, 1760 yards is 3-inch Mannesmann steel tubes, and 2540 yards is 2-inch screwed and socketed steel tubes. All services are of wrought-iron tubes (steam quality); and in future all new mains will be screwed and socketed wrought-iron pipe, which I consider best for high-pressure distribution.

It is a noteworthy fact that, although we are now distributing gas at from 3 to 60 inches of pressure, in the past year, instead of our leakage being increased, as might be expected, it has been actually reduced 2 per cent.

From the foregoing description, it will be seen that the pressure-raising apparatus in the works, and the distributing and governing arrangements, are of the simplest possible description, but substantial enough to give us no anxiety for the future. It would be easy to elaborate our system; but from experience I can say that the more simple the system of high-pressure distribution the more reliable and successful it will be. We will also, in a short time, be increasing the initial pressure by our existing blowers, in order to supplement the supply in one or two badly supplied low-pressure districts in Lochgelly.

Of course, it is understood that every town has special and distinct requirements peculiarly its own, and any scheme of high-pressure distribution must be developed according to those requirements.

"Keep down the pressure in the mains" is a rule which has had its day and served its generation. The rule has now no significance, and gas managers would do well to devote some little study to the new money-saving device for "raising the pressure in the mains."

A FEW NOTES ON HIGH-PRESSURE GAS SUPPLY.

By Alex. Waddell, Dunfermline.

I was asked to consider the supplying of gas to certain districts, the respective distances to the centres of which from the gas-works were 2¾ miles, 1¾ miles, and 4½ miles; the average altitude being 144 feet below the gas-works. The probable supply required (say) within the next ten years, is a most uncertain quantity; but meantime it has been taken at over 20,000,000 cubic feet per annum. The supply required within the next three years may be taken at 2,500,000 cubic feet per annum.

It was difficult under the circumstances to see how a low pressure supply could be given with a hope of success financially, at least for some years to come, owing to the large initial cost of a low-pressure feeder; and a portion of the district was anxious to

have a supply at once at a moderate price. Thanks, however, to the high-pressure system and its pioneers, good service at moderate cost to the consumers, with satisfactory returns to the undertakers, is made easy; and hence, in the circumstances here referred to, there was no hesitation in adopting this system. A number of papers have been read on this subject at kindred meetings, which, along with other articles, have appeared in our gas journals; and as we have had to-day such an able further contribution from my neighbour, Mr. Keillor (see p. 305), I propose to leave the general subject alone, and will content myself with trying to put before you a few points as they occurred to me in connection with the supplying of the districts referred to.

The pipes as laid are tested at 50 lbs. air pressure by a piston compressor. While a very moderate pressure will be sufficient at the beginning, it will require to be gradually increased up to 20 lbs. per square inch, to deliver 20,000,000 cubic feet per annum—not that 20 lbs. pressure is wanted at any of the districts, but this pressure will be necessary at the compressor to deliver the above quantity during the maximum night demand. Then, as the demand varies from the maximum required during the night to the minimum during the day, it is evident that, though the pressure was kept constant at the compressor outlet, it would vary at the districts from 20 lbs. downwards according to the delivering capacity of the pipes; and this minimum might be a quite inadequate pressure for the consumers, and the variation far too great for the satisfactory working of even high-pressure district governors. No one questions the need for, or advantages of, a constant and suitable pressure in mains at the points of distribution. Now I should be very pleased, and have tried, to learn that this has been done, but without success so far; and to accomplish this has been one of my objects.

Compressing plants, as now, are set to give a stated pressure at the outlet, and to some extent to maintain this pressure by continuing to recompress, let us say, a surplus quantity (which is waste power), equal to 30 per cent. of the total. In fact, the work of the compressor is not in sympathy with the requirements of the consumers, or the capacity of the feeder main; and it is certain, especially when the capacity of the feeder main is well taxed, to give an excessive pressure during the day, and an inadequate pressure at night, even though an attendant is constantly employed adjusting the compressor.

I have already referred to the cost of a low-pressure feeder pipe as being quite prohibitive, and as the present high-pressure main feeder, including compressor, is to cost £1500 to supply an estimated consumption of 2,500,000 cubic feet per annum during the third year, sinking fund and interest on these alone amount to 8½d. per 1000 cubic feet, which is quite a large amount, and deserves very careful consideration. Hence the need of keeping the size and capacity of this high-pressure pipe within reasonable limits; and this is secured by laying it to withstand, and, when necessary, working it up to, a pressure of 20 lbs., or even up to 40 lbs. But when the time comes that 20 lbs. is necessary at the outlet of the compressor, the pressure may vary anywhere from that amount to (say) 2 lbs. or *nil;* and, as already stated, this variation would be altogether unsatisfactory.

After a good deal of consideration of different schemes, I have determined to regulate the supply of steam to the compressor, and in this way regulate the compressor automatically, to give any stated pressure at any point required—and this without any unnecessary recompressing—by arranging that the pressure in the main 3 miles distant is communicated to the steam-valve of the compressor, which it opens or closes according to the demand for gas in that district. The pressure in the main is communicated to the compressor by a ⅜-inch bore block-tin pipe, laid inside the high-pressure main. As the length of pipe is about 3 miles, provision for the testing of it in sections may be necessary, and is arranged for. Then, as the length of the main high-pressure pipe is the same, and the pressure it may have to bear is so much more than usual, it was considered desirable to have facilities for testing this pipe also, in sections.

For the purpose of facilitating the testing of the large and the small pipe in sections, for the withdrawing of the small pipe if necessary for repair and reinserting, and at the same time to form water-traps, I have got combination boxes made, two of which are here for your inspection. They are simple and moderate in cost. To begin with, some fear existed regarding the effect by friction of drawing the block-tin pipe from box to box, through about 200 yards of the main; and provision was made to avoid any damage to it. But this has been found unnecessary.

I would like, in closing, to put forward with as little bias as I can what I think may be claimed for governing the compressor by the pressure in the main in the district supplied, and thereby maintaining a constant pressure therein, compared with simply maintaining a constant pressure at the outlet of the compressor.

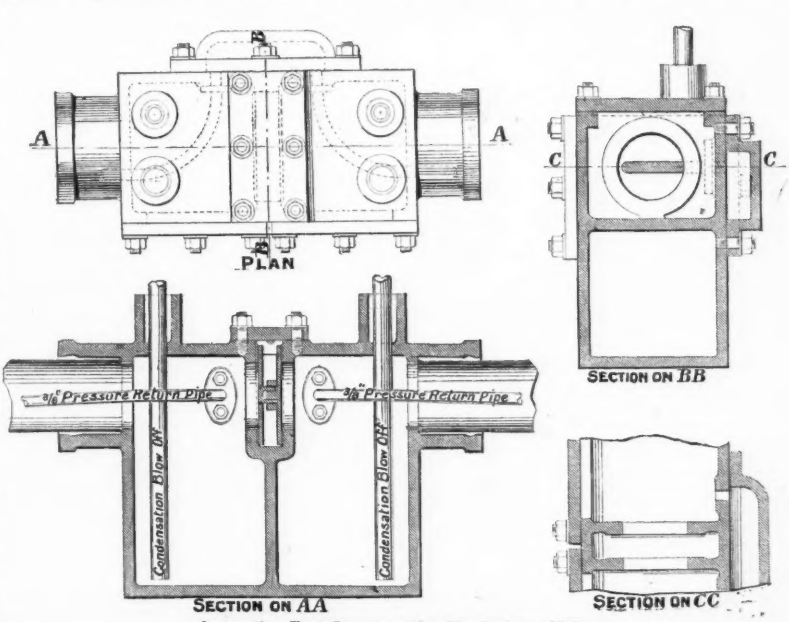
1.—That the plant costs less because it has no unnecessary work to do, and therefore less work; and that it automatically gives the maximum, minimum, and any other demand exactly when and as required.

2.—That the cost of running the compressor is much reduced, because practically no attendant is required; whereas attention by men would have to be constant, except where surplus capacity in piping exists and recompressing is resorted to.

3.—That the means of regulating the compressor, as proposed in these notes, gives a constant predetermined pressure in the district being supplied, notwithstanding the varying demands, compared with the present way, which only gives a constant pressure at the outlet of the compressor; and this pressure will vary in the district to be supplied in accordance with the varying demand made on the capacity of the high-pressure pipe.

Discussion.

The PRESIDENT (Mr. W. Blair, of Helensburgh) said the two papers would be discussed together. They were very much indebted to their young member, Mr. Keillor, for the first one, which was really a maiden effort. It was a very valuable paper, and one which must have cost the author a great deal of thought, not only in its preparation but in arriving at the results. High-pressure distribution of gas was coming more prominently before gas managers every year. He himself happened to have a pretty large district to supply, with a sea-front of about seven miles. He had, practically, 50 miles of mains in Helensburgh, and the largest consumer was nearly 5½ miles from the gasholder. The consumption had increased about 20 per cent. within the last ten years; and he had found difficulty in maintaining an adequate pressure at the point of largest consumption, which happened to be the Shandon Hydropathic establishment—especially in the Christmas and New Year weeks, when they would have from 350 to 400 lights going at one time. He had been asking his Committee for the last two years to augment the pressure by supplying a blower or pressure intensifier. As their storage capacity was only about 260,000 cubic feet, at 33-10ths pressure, 100,000 cubic feet of it could never be supplied at more than this; and to give anything like from 20-10ths to 24-10ths at the outlet, they practically required a 4-inch pressure. So that to have met their requirements they would have had to augment the pressure by about an inch. However, their storage capacity was deficient, and they had spiral-guided and telescoped an old gasholder, increasing their storage, at upwards of 4 inches of pressure, by another 160,000 cubic feet. For a number of years, therefore, unless the demand in the outlying district continued to increase, they might now be able to furnish an adequate supply with the holder pressure. But as the place grew, they would certainly, at some not far distant date, require to augment their pressure by an intensifier or a blower. The papers which had been brought before them thus appealed, in a special sense, to him, though it was a higher pressure rather than an intensifier that he wanted, because he found that, by raising the pressure to 4 inches, even at the highest rate of consumption, he had sufficient for all purposes. Gas distribution had greatly changed within the last year or two. An increased demand for gas for manufacturing and cooking purposes required a heavier day pressure, and incandescent lighting and the reduction of illuminating power demanded a heavier night pressure. As Mr. Keillor had shown, and as he (the President) had mentioned, it was possible to obtain this additional pressure without increasing the unaccounted-for gas. One of the things he found was that if there was ever an escape of gas at the higher pressure the more



Inspection Test-Boxes on the Charlestown Mains.

pronounced it would be, and the sooner it would be perceived. He believed that to this was partly due the reduction in the unaccounted-for gas in Helensburgh; and he had no doubt that the same thing would be applicable to many more places.

Mr. A. YUILL (Dundee) did not think there could be any doubt about the benefits to be derived from the distribution of gas under high pressure, especially when they were dealing with a district in which their mains were defective or too small. In his own case, he had mains of 30 inches diameter on leaving the works, and afterwards becoming 24-inch mains. From the information now before them, he thought that anyone would be ill-advised in recommending his directors or committee to lay a 24-inch pipe in these circumstances: Supposing they wanted to deliver gas at a distance of even five miles from the works, a 4-inch pipe, under high pressure, would give delivery at that point of all the gas that might be required. He (Mr. Yuill) noticed in Mr. Keillor's paper—and it was a point upon which he should like a little information—that, in delivering the gas, his pressure fell considerably from the initial; and he did not see why this should be. If they were dealing with a pressure of 40 or 60 inches—and this, he might mention, was comparatively low when they were dealing with the newer systems, working up to 60 lbs. pressure per square inch—they ought always to be able to maintain the pressure in high-pressure mains at the initial figure. He must congratulate Mr. Waddell on the system he had adopted for maintaining uniformity of pressure. He brought into action what they had all done, to some extent, in the governing of exhauster engines. In his own case, he carried a 1½-inch pipe from between the hydraulic main and the condensers right into the exhauster-house, so as to give, as nearly as possible, the fluctuations on the hydraulic main; and he found considerable benefit in doing so. Mr .Waddell tried to get the pressure at the extreme end of the high-service main to govern his pressure-raiser at the initial pressure. It was a well-devised plan, and he thought they ought to congratulate Mr. Waddell on having brought his method to what they might term a practical result. He had always held the opinion that the higher they raised the pressure, the unaccounted-for gas always had a tendency to decrease. Most of them had experience that, when dealing with pipes which were somewhat defective, if they had a pressure of 5-10ths, which they might take as the minimum pressure for gas till a few years ago, an escape might occur, and it was never detected. But if they raised the pressure to 20-10ths, it was more than likely that they would find the escape, and it would be attended to; so that it was almost an axiom that the higher they raised the pressure the better in hand they got the unaccounted-for gas. He should like to ask Mr. Waddell as to the compo. pipe. How did he deal with condensation that would take place occasionally, even in his small pipe? He knew the difficulties that arose with the gas travelling several miles. Roads were not all level—there would be some depressions here and there in the pipe; and he should like to know how Mr. Waddell got over the difficulty of the condensable matter which might collect.

Mr. D. ROBERTSON (Dunoon) remarked that Mr. Keillor had given the members a paper which was unique in this respect—that the scheme had been applied to a district which had risen by leaps and bounds. He believed it would suit such a district much better than an older one, where there might be wet meters and other things in operation. They must feel that there was a certain danger connected with the use of governors, if they had gas entering them at a pressure of 50 inches, and leaving, it might be, at a pressure of only 3 inches. This pointed to the possibility of the governor going wrong; and in parts of his own district he would not feel comfortable if he knew there was a governor liable to go wrong, and throw a pressure of 50 inches on to all the wet meters and water-sealed gaseliers in the district. He should feel there might be a catastrophe if this happened. All the same, in districts like Lochgelly, where houses were rising by the hundred, the gas managers could prescribe certain classes of fittings; and then, though the gas should pass the governor, the lights might be disturbed for a time, but there would be no damage. In his opinion, it would be an excellent system in such a place, and would result in a saving. At the same time, he did not know that it would be so very great as was contemplated, because there must be a good deal of expense in procuring the high pressure, and a certain amount of outlay incurred in supervising the exhausters. It was a case in which they should be careful not to run into the other extreme. A great many of them had been brought up to think that it was the right thing to keep down the pressure in the mains; and it was very difficult to get out of one's mind that if the pressure were increased the leakage would be increased also. He thought this held good to a great extent. To hold that if they doubled the pressure the leakage would decrease was entirely wrong. It might be said that by doubling or trebling the pressure an escape which had not been detected for years might be located; but what did they make of a small escape? If they trebled the pressure, they trebled the escape. With regard to Mr. Waddell's paper, he had doubts as to whether a ⅜-inch block-tin pipe would carry a pressure of 50 lbs. Mr. Waddell assured him, before the meeting, that it would; but he would certainly put in a stronger pipe. There was just the danger of the pipe being holed, through being scratched or torn a little; and if they were going to draw a pipe of this sort through several hundred yards of cast-iron pipe, with probably a little rust on the inner surface, they were bound to damage the smaller pipe, probably rubbing away half its thickness; and then they would not be able to put 50 lbs. of pressure upon it. He should like to ask what would happen if the pipe were damaged half-way along, and a leak took place. These were interesting points, and he should be glad to have the questions answered.

Mr. D. VASS (Airdrie) thought the members were very much indebted to Mr. Keillor for his courage in entering upon a new field. It was a great step for a young manager to make such a departure as he had done; and it showed a large amount of spirit on his part. He (Mr. Vass) should like to ask him, with reference to street lighting, if he took advantage of the high pressure he had in his mains to obtain a better result in street lighting. It would, he supposed, be necessary that on each lamp he should have a governor, reducing the pressure to that of the consumption. It seemed to him that Mr. Keillor had there an ideal and up-to-date system, which would be of great service to some of them who were in more crowded quarters than he was. He took it that most of his district was under the high pressure, and that only at outlying parts was it reduced by the district governor to ordinary pressure. The point was, perhaps, not so clear as they would like, and therefore he put the question. As to Mr. Waddell's paper, they seemed to have some doubt in their minds as to whether a ⅜-inch pipe would carry back a sufficient volume of gas to operate any valve for regulating the apparatus at the works. The volume that would come through such a pipe would meet with so much resistance on the way that it might be thought advisable to put in a considerably larger size than ⅜-inch compo. He would like to know if Mr. Waddell had any experience to guide him on the point as to whether a pipe of this kind would be sufficient.

Mr. FORBES WADDELL (Queensferry) expressed the opinion that many managers of small gas concerns were in districts which would admit of development if a high-pressure system of distribution were introduced. Mr. Keillor had, he said, shown this very clearly. He (the speaker) had gathered from the paper that without a great deal of extra expense he would not have been able to supply these outside places with gas as he had done. There were one or two villages not far away from his own place; and if he had to take a 6-inch pipe to them, the cost would very soon mount up so that it would be necessary to charge a prohibitive price for the gas. In other words, it might not be a practicable scheme. In distributing gas, he had always looked at the matter in this way—that a manager found out what was his pressure in the outlying part of the town, and he increased it until he satisfied the consumers at that portion of the town. In Mr. Keillor's case, the pipes were too small for this; and he took a very common-sense view of the matter. He adopted a compressor, and saved himself a great amount of trouble and expense. The relative pressure and leakage was at the outer distribution point. If the pressure were not more than what was necessary at this point, the leakage would surely not be more than might be looked for. It seemed to him that if the pressure at the outer district kept in touch with the compressor, as in his brother's appliance, there could not be any excessive leakage, for the reason that whenever the pressure in the outer district exceeded (say) 2 inches, it acted on the compressor.

Mr. J. NAPIER MYERS (Saltcoats) said it was difficult, in discussing two papers like those before them, to keep them entirely distinct in one's mind; but he might say that in the reading of the first, by Mr. Keillor, he did not do himself the credit to which he was entitled, by making so little reference to the admirable diagrams he had exhibited. In the early part of his paper the author referred to the work done by the Gas Company themselves, under contract. He (Mr. Myers) would like to ask if he did so on true commercial lines, or whether any of the work was done at or below cost price, or at a profit. Throughout the paper Mr. Keillor spoke of high and low pressure, without defining what he meant. These were quite relative terms. He supposed they would be right in assuming that the pressure at which they had usually distributed gas would be termed low pressure; and that anything above this would be considered high pressure. One pound per square inch was something like 27 inches of water. When they said that a fluid was being distributed at 1 lb. per square inch, this, after all, was a comparatively small pressure; and yet, as they understood the distribution of gas, it might seem a high pressure. Perhaps, to some of them, what was meant by high and low pressure might have been more clearly defined. Towards the end of the paper, it was stated that all the services were of wrought iron, and that in future the new mains would be screwed and socketed wrought-iron pipes. He should like to ask the author why he had so distinctly stated his preference for wrought-iron tubes, instead of (say) solid-drawn steel tubes; and why he should prefer screwed and socketed pipes instead of a lead joint. They knew the difficulty there was in dealing with large screwed and socketed tubes. Then he referred to a subject which had often been before them—viz., that keeping down the pressure in the mains had no significance now. He was one of those who continued to think that the rule had still as much force as when it first came under their notice, and that no pressure should exist in mains beyond what was absolutely necessary, whether they called it high or low pressure. With regard to Mr. Waddell's paper, he might also say that the author did not do himself the credit he should have done. He had brought before the members a new and very interesting principle—that of bringing back from the extremity of the distributing system the conditions existing at the source of the service; but he had not expressed himself

with the clearness which the subject warranted. The means the author adopted to do this might reveal some defects in practice; but Mr. Waddell was on the right lines. The internal tube might prove to be too small, as Mr. Robertson thought; but this could be remedied. He would suggest that the connection of the bye-pass with the rectangular box should be put at a lower level, so as to be able to drain off any moisture which might collect in the pipe.

Mr. J. Dickson (Kelty) thought Mr. Keillor would bear him out when he said that his consumption had increased at a very great rate during the last few years; and he was sure he would be astonished himself if his leakage had not gone up. In his opinion, the high-pressure method of distribution was the very thing he ought to have adopted. Pressure should, however, be kept down to just what was sufficient for the requirements of the consumer. If 29 inches was sufficient during the period of full consumption, as shown in Mr. Keillor's table, 60 inches was more than was necessary; and it followed that the leakage in a pipe under this pressure would be more than it ought to be. Mr. Waddell tried to get over this by regulating the pressure to the requirements of the outside consumers. This was an excellent idea, and one which they might yet find useful in a low-pressure system, though, at the same time, he did not know that a pressure of 40-10ths would be carried back to the governor, to regulate the pressure at the works. The apparatus, would, however, do sufficiently well for Mr. Waddell's purpose. It had been remarked that there might be difficulty in getting the pressure carried back from the extremity of the system to the works. He did not see that there would be any difficulty on this score, because it was not the same as if the gas were travelling through the small pipe. Mr. Waddell would derive advantage from the pipe being carried back, by keeping the leakage down to a minimum.

The President, in closing the discussion, remarked that both papers were certainly very interesting. In looking over the table given by Mr. Keillor, it seemed to him that if Mr. Waddell's device were applied, there would be no practical need to have any higher pressure than 29 inches to be able to maintain 8 inches during the highest consumption. By adopting this method, they found out what the consumers at the extreme end of the service were receiving in the way of pressure. In his own case, he might on many occasions be able to give an extra tenth or two pressure, if he knew there was a deficiency; but, as it was, he preferred to have as little fluctuation on the main as possible. There was a great deal to be said for both questions. As to hauling the pipe into the main, he did not think there was much in that, because there was a limit to the length in which compo. pipe was made, and the main would be laid to suit this. They would not have the entire four or five miles of main to haul it into. It would be hauled in from boxes; and he supposed their position would depend largely on the rise and fall of the road.

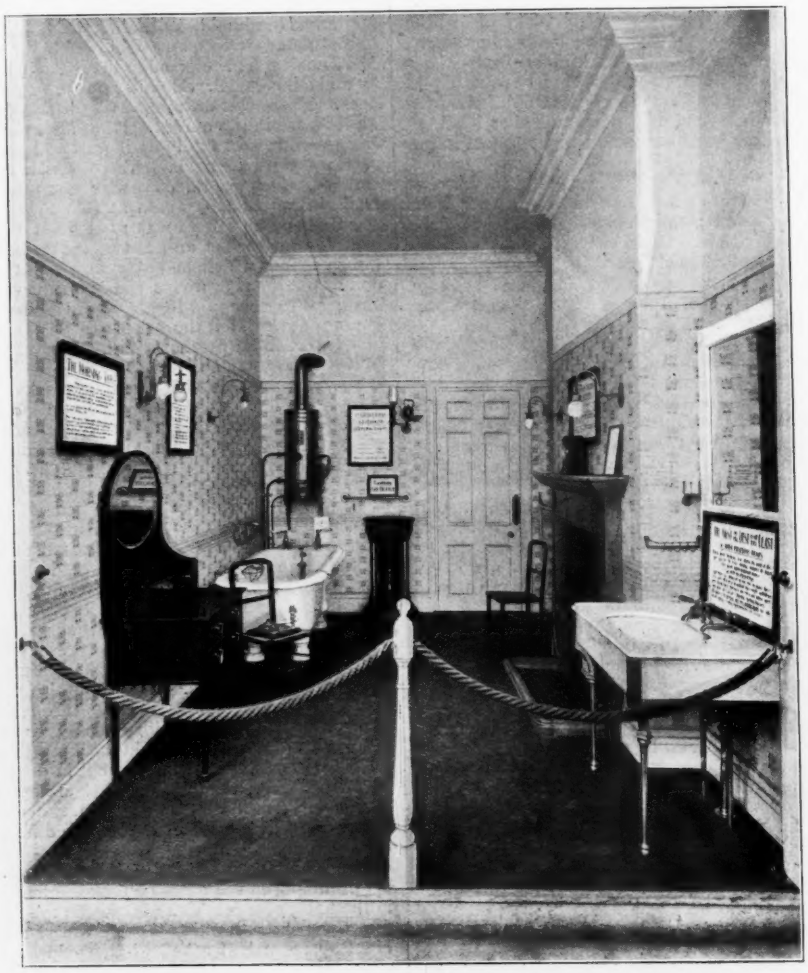
Mr. Keillor thanked the members for the kindly manner in which they had received his paper, and said he was pleased they had found in it so much food for reflection. It was very evident that the subject of high-pressure distribution was being seriously considered by not a few of those present. Villages within reach of towns, hitherto without a gas supply, through the prohibitive cost of low-pressure mains, could now be easily and profitably tapped. Its applicability to such cases was a good feature of the system. Mr. Yuill did not see any reason why the full pressure should not be kept up in the main during the whole period when the blowers were running. This was rather a difficult matter, for naturally, through the travel, the loss of pressure would be at the most distant point. By having unnecessarily high pressure, it might be possible to keep up 20 lbs. or 30 lbs.; while in his own case probably 60 inches would suffice. Mr. Robertson had fears and doubts as to the reliability of the governors; but he could assure him that, so far, they had not given any cause for anxiety. Of course, there were numerous safety devices which could be installed to reduce the risk. Mr. Vass had spoken about street lighting. He (Mr. Keillor) had no street-lamps in his district at present; but he might say that the County Council had the question before them, and a lighting district was likely to be formed in the coming winter. It would all depend upon the Council whether or not high-pressure lamps would be installed. If they were, each lamp would be governed in the usual way, or rather in the way described in his paper; or, in order to save governors, they might run a service from the nearest house governor. He expected there would be about 150 lamps to begin with. Mr. Myers had asked about the gas-fitting of the houses. They did the work under contract; but he might say that practically all the houses belonged to the coal companies, and the Council gave the companies a price per house, according to its size. They ranged from one room to three rooms and a scullery, and they got from 9s. to 13s. 6d. per house. They let the contracts to local plumbers, who made considerable profit out of the work. With regard to screwed and socketed wrought-iron tubes, needless to say there was a great saving in time and labour in laying them; and they also did away with the risk of a bad joint springing through heavy traffic. Probably it was a matter of opinion, but he considered the screwed and socketed malleable or solid-drawn steel tubes were best suited to the purpose. When he spoke of wrought-iron pipes, perhaps he meant solid-drawn steel tubes. As to the question of high pressure or low pressure, he did not know where the dividing-line would come in. Probably anything up to 3 or 4 inches would be termed low pressure. To get high-pressure lighting results, they required at least 8 or 10 inches. He should say that anything above 10 inches, or about half-a-pound per square inch, could be termed high pressure. Mr. Dickson had referred to the leakage increasing as the output or make increased. He did not see why this should really be the case. There was no reason why leakage should be greater with an increase in the output. Naturally, when a district like theirs was growing so rapidly as it was, and so many new mains and services were being laid, there was a considerable amount of leakage, which would otherwise not take place at all. If Mr. Dickson would look again at the table in the paper, he would see that the 29 inches was at a point three-quarters of a mile from the gas-works, and not at the end of the main. Opposite the 29 inches which he got at that point he had 8 inches at the end of the district, where the governor was fixed. Beyond this governor there would be about 300 consumers taken off, and the governor regulated the supply to all the houses, irrespective of any variation of pressure that there might be on the inlet side of the governor.

Mr. Waddell, in reply to the remarks on his paper, said Mr. Yuill raised the question of condensation in the small pipe. He would note that this had practically been answered already. There was small space for, comparatively speaking, a large condensation; and this condensation they could take off. But, as a matter of fact, the gas was only travelling backwards and forwards inside the pipe. Indeed, it could be filled with dry air in the first instance; and that air would in all probability remain in the pipe. Even if the pipe was filled with water, this would not prevent it from doing its work, though he would prefer to keep it dry. The next question asked was as to the reliability of the pressure. If they looked upon the small pipe as purely and simply a pressure pipe, they might have a gauge always attached to it, beside the compressor, and it would give the pressure at any time. To make sure that it was a pressure pipe, they would require to have a tap, to cut it off at any time. His proposal was that they should have the high-pressure mains running through the district, and what they might call street-mains, with a governor on each, taken off; and even although they might not have the pressure in the high-pressure mains, they would have it in the street-mains.

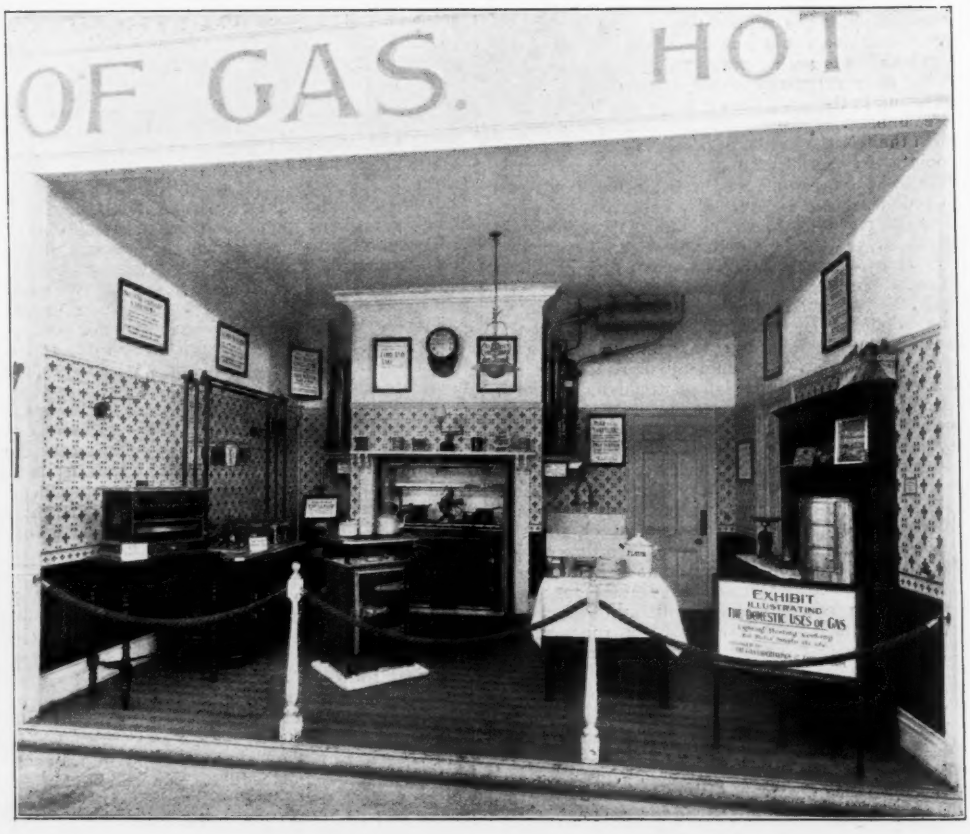
Mr. J. M'Farlane (Maybole) asked whether, if there was a pressure of 50 lbs. at the inlet of the main, and not far off there was in the return pipe a pressure of 10 lbs., the difference would not crush the small pipe flat.

Mr. Waddell replied that it would not. He might say that before he put in the pipes he took the finest pipe gas fitters were in the habit of using, placed it inside the main, and put on 50 lbs. of pressure, and it did not touch the small pipe in the slightest. Mr. Robertson had asked what would happen if the small pipe were damaged. If it were cut right through, all that would happen would be that the pressure would be kept constant at this point, instead of at the distant point. One thing he had tried to make clear—and he was not sure that it had been noted—was that the delivering capacity of any pipe was the greatest factor in the whole thing. The greatest factor was not the area of the pipe, but the difference of pressure—the difference between the initial pressure and that at the point at which the gas was to be delivered. If they had 20 lbs. pressure at the outlet of the compressor, and 10 lbs. at the other end, this would not deliver anything like so much gas as if they had 20 lbs. at the compressor and 2 lbs. at the other end; and it was largely to serve this purpose that he had given himself the trouble he had done. Mr. Myers had raised a point about the screwed joints. He had adopted lead rolled joints, and had tested them to 50 lbs. pressure, and had not had any difficulty whatever with them. With regard to the question of the higher pressure blowing water-seals, with his arrangement they might fix their pressure at anything they pleased at the far distance, and maintain it. They might call it high-pressure distribution, only they might have the pressure within the centre of the district 5, 6, 7, or 8 inches. There was no limit to it at all. However, he proposed to keep at such a pressure as would enable him to put on one of Keith's latest high-pressure lamps, requiring 54 inches, and then govern down to about 4 inches in the street-mains. He thought it was worth their while to be able to show such a high light as they had seen at the Exhibition; and he intended to risk it. They were not limited as to the quantity of gas they consumed in the public-lamps; and, by burning something like a cubic foot of gas they would have a much better light than they were getting with 3 cubic feet. During the day he would be able, by means of his arrangement, to reduce the pressure, if desirable, to whatever he pleased. In conclusion, he had only to say he was much obliged to the members for the way in which they had spoken of his paper.

Determining the Calorific Value of Gases.—A French patent has been taken out by Herr F. R. Schönberger for an apparatus for determining the calorific value of gases. According to an abstract of the specification in the "Journal of the Society of Chemical Industry," the method is based on the fact that the speed of conflagration of a gas is in a determinate proportion to its calorific value, and also depends on its pressure. The apparatus consists of a burner and a regulating valve, which controls the inflow of gas from the source of supply into a receiver, to which is attached a manometer tube. The height of the flame and the gas pressure are read off on graduated scales attached to the burner and the tube; the pressure being regulated by the valve until the flame is on the point of extinction.



THE ASSOCIATED GAS UNDERTAKINGS' EXHIBIT AT SHEPHERD'S BUSH.



ASSOCIATED GAS UNDERTAKINGS' EXHIBIT AT SHEPHERD'S BUSH.

On this and the preceding page there are reproduced three photographs which have been selected from an excellent series of seven pictures that have recently been taken of the apartments, &c., embraced in the Gas Undertakings' exhibit at the Franco-British Exhibition. They are, of course, self-explanatory; and even if this were not the case, the exhibit has already been so fully described in the "Journal" that any detailed account here would be unnecessary. The very large number of gas engineers who have already visited the Exhibition will have their memories refreshed by the photographs; while those who have not yet been will derive from them a good idea of the complete and dainty character of the exhibit.

There is, however, one other remark that may be made about the photographs. It has been suggested—and it is an idea with which we find ourselves in full agreement—that the series of pictures would be very suitable for placing in the show-rooms of gas companies, and might besides possibly be useful to companies when arranging exhibits for themselves. The photographic prints which are before us are good in every respect, and would be likely to attract considerable attention if hung in a prominent position in a show-room. Copies, it may be added, can be obtained at the price of 2s. 6d. each, on application to the photographers—Messrs. Campbell-Gray Limited, of No. 17, Cheapside, London, E.C., who are the official photographers at the Franco-British Exhibition.

THE SECOND LARGEST GASHOLDER IN THE COUNTRY.

It is not yet built; but the work is being prosecuted with energy. Reference is here made to the building of the gasholder that will cause all gasholders in this country that rank nearest in size to the East Greenwich 12 million cubic feet holder to go down one place. This new holder is being built for the Manchester Corporation Gas Committee, at the Bradford Road station. There was no deliberate design on the part of the Gas Committee or of their Chief Engineer (Mr. J. G. Newbigging) to take the premier position in the Provinces by erecting a gasholder of such large capacity; but it all the same remains true that what they are doing gives them this position. The factors that decided choice in the matter were, first, that the Committee wanted, through the progress of gas consumption, a considerable extension of storage to place them in a position of absolute safety on those days when, in Manchester, dense atmospherical conditions cause considerable leaps in the demand for gas, and the Committee do not want to be charged with culpable negligence; secondly, they had a vacant site at Bradford Road that was suitable for a 10 million cubic feet gasholder; and, thirdly, they found a saving was to be effected per 1000 cubic feet of storage by adopting a holder of this size. Therefore, there was every good reason why a holder of the capacity named, or rather nearer 10½ millions, should be constructed. The work on the tank is now being vigorously prosecuted by Messrs. Nuttall and Co.; and the contract for the holder has been let to Messrs. Ashmore, Benson, Pease, and Co. It is expected that the holder will be ready for use by about December, 1910.

Such an important piece of work could not go far without a little function; and such functions give an opportunity for allowing the general body of members of the Corporation to see something of the immensity of the new work required by their flourishing Gas Department. Therefore, the Gas Committee invited the Corporation to witness last Wednesday the laying of the foundation-stone of the holder tank by their esteemed and energetic Chairman (Mr. Alderman Gibson). The large party were accompanied by the Lord Mayor (the Right Hon. Edward Holt, J.P.), and by most of the chief officials of the Corporation, whose names appear in the notice of the proceedings at the dinner in the evening. The journey to the Bradford Road works was made by special tramcar, where Mr. Newbigging and the Station Manager (Mr. J. R. Hill) met the visitors. To afford information by visual comparison, an inspection was first made of the existing holders. There are four as alike as peas in a pod. They were constructed in 1881, and stand grouped together. They are each 144 feet in diameter, of three lifts, and of an individual capacity of 1,700,000 cubic feet of gas, or together 6,800,000 cubic feet. There is a later holder, in which the heavy columns are dispensed with, and the more modern latticed type of standards take their place. But it was explained to the visitors, that while the four holders necessitated four tanks 144 feet diameter, and together gave storage for only 6,800,000 cubic feet, this later three-lift holder has a capacity of 7 millions, and yet is accommodated in a tank 250 feet diameter. This part of the works was then left; and the visitors walked round to the site of the new 10 million cubic feet holder, where excellent progress with the tank work is being made by Messrs. Nuttall and Co.

Before proceeding with an account of the afternoon and evening's proceedings, some particulars of the embryo tank and holder may be given. Dealing first with the tank. It will be 285 feet in diameter, and 43 feet deep to the top of the rest-stones; the extreme depth to the footings being 50 feet. The excavation for the tank-walls, &c., necessitates the removal of about 107,000 cubic yards of soil. Of clay puddle 7940 cubic yards will be required, and of cement concrete 5660 yards, and

some 4 million bricks will be needed. As will be seen from Mr. Newbigging's speech at the dinner, the bricks are being made on the site from the available clay. The thickness of the tank wall will be 5 ft. 6 in. at the base, and 2 ft. 9 in. at the top. Altogether, some 10,225 cubic feet of stonework will be required. A survey of the timber in use in the excavations until the walls are built supplies the following figures: Polling boards, 89,500 superficial feet by 1½ inches thick; waling timbers, 14,660 cubic feet; struts, 18,330 cubic feet; and punchings, 3000 cubic feet. It has been mentioned that the total depth of the trench excavation is 50 feet; but the overall depth at the pipe recess is 56 ft. 9 in. The estimated total weight of the steel and ironwork in the tank framing is 258 tons. It is calculated that 9,042,018 gallons of water will be needed, or 40,366 tons. The cost of clearing the site amounted to £3125; and the estimated cost of the tank is £30,990.

Turning next to the holder that has been designed by Mr. Newbigging for this tank, and which (as stated above) is to be constructed by Messrs. Ashmore, Benson, Pease, and Co., it is to be in four lifts of the following sizes: Outer lift, 282 feet diameter by 42 ft. 6 in. deep; third lift, 279 feet diameter by 42 ft. 6 in. deep; second lift, 272 feet diameter by 42 ft. 6 in. deep; and inner lift, 273 feet diameter by 43 feet deep—the total capacity being 10,410,000 cubic feet. The height from ground-level to the top of the guide-framing standards will be 169 ft. 6 in. From the ground-level to the top of the holder crown the height will be 182 feet when filled. The number of steel standards and guides will be 32, each weighing 30 tons complete. The floating weight of the holder will be 1607 tons. The total weight of steel and ironwork in the holder complete (excluding the tank framing previously given) will be 3080 tons. The estimated cost of the holder, with the tank-framing and the inlet and outlet pipes, will be £52,600. Adding together the cost of the tank and holder, it is seen to work out to £8 os. 7d. per 1000 cubic feet; but there are deductions to which reference was made by Mr. Newbigging in his speech at the dinner.

These are some of the main features of this large holder and tank, the laying of the foundation stone of which by Mr. Alderman Gibson the large company went to witness on Wednesday last. Before the ceremony, the party passed over the trench; and at a spot by the side of the huge trammel and near to what will hereafter be the centre of the top of the dumpling, the whole company were photographed with the Lord Mayor, Alderman Gibson, and members of the Gas Committee in central positions. Then, by a specially constructed stairway, they all descended 50 feet to the concrete bottom of the tank trench, and gathered round the foundation stone that Alderman Gibson was soon to consign to its proper position. As soon as the whole party had assembled,

Mr. EDMUND NUTTALL, representing the contractors for the tank, said they had now arrived at a most interesting point in the carrying out of this contract, in the laying of the foundation stone by Mr. Alderman Gibson. If Alderman Gibson put the same energy into the laying of the stone that he put into the work of the Corporation Gas Committee, all present would be satisfied that it would be well and truly laid.

The LORD MAYOR said he had been asked by the contractors to present to Alderman Gibson a trowel and mallet with which to do the work. In handing these tools to Alderman Gibson, he might say it was only right that he should have the honour of laying the stone. He had been Chairman of the Committee for fourteen years, and a member of it longer than that; and during these fourteen years, he had done his best to make the gas undertaking a grand success. Their friend had spared no trouble, labour, or money (even from his own purse), when he had felt it was to the interest of the Gas Committee that certain things should be seen or should be done. They all knew Alderman Gibson; and they all liked him. He had his peculiarities; but they were lovable ones. If he did not get his own way in all things, he (the Lord Mayor) knew of no one who could get the Council to his way of thinking better than their friend. He said at the beginning of his remarks that it was a fitting thing the Chairman of the Gas Committee should lay this stone, for it was the biggest undertaking to which the Committee had ever put their hands. It would be the largest gasholder they had in Manchester; and he believed it would be the largest but one in the United Kingdom. Manchester had always been to the fore in the size of its undertakings; and he thought this was very creditable to the city. Their undertakings were enormous ones; and no one could realize their size without visiting them. No one, for instance, could possibly imagine the size of the gas undertaking from merely reading the reports of the Committee. For fourteen years, Alderman Gibson had been at the head of the Gas Committee without a penny of payment, except the feeling of pride he must have in having brought, by the aid of his colleagues and the officials of the department, the concern to a more successful condition than it held fourteen years ago.

The trowel and mallet which the Lord Mayor on behalf of the contractors presented to Alderman Gibson were chaste examples of workmanship. The trowel was of silver with ivory handle, and the mallet was of ivory with silver setting. The blade of the trowel bore the inscription

Presented to

Alderman ROBERT GIBSON, J.P., Chairman of the Gas Committee,

On the Occasion of the Laying of the Foundation Stone of No. 6 Gasholder Tank, Bradford Road Gas-Works, Manchester.

July, 1908.

(The arms of the City of Manchester followed.)

The huge stone with which Alderman Gibson had to deal was attached to a large crane by chain ready for moving into position. In the top of the stone a hole had been cut into which was to be deposited a lead box containing one of every coin of the realm from a sovereign to a farthing, a copy of four local newspapers, a copy of the "Journal" and of the "Gas World," the official manual of the Corporation for 1908, the annual balance-sheet and accounts of the department for the last financial year, and a list of the names of all present at the ceremony. In some distant age, there will be an interesting find for someone in this foundation stone.

Alderman Gibson, in workmanlike manner, spread the compo. on the concrete bottom of the tank trench at the place where the stone is to rest; and then, at a signal, the huge block was raised and lowered again into the position it will occupy for many a generation. Then the leaden box was deposited in its cavity, the top of which was covered by an iron plate, fastened into position by an iron bar, with ends bent to an angle, and leaded into sockets in the stone. All this work having been well and truly done,

Alderman GIBSON addressed the witnesses of his skill who were circled around. He remarked that though this was neither the time nor the place when they could expect him to make what could, by the wildest imagination, be described as a speech, he thought that perhaps this was the time and the place when he should give his colleagues on the Council some reason as to why the Committee had decided to erect so huge a holder. It was the fixed idea of the Committee that they should have at least gas storage power equal to one day's consuming power—that was to say, that they should have at least as much gas in stock as would supply their customers on the most foggy of days. In 1897 the holding power was practically 19 millions, and the largest day's consumption at that time was 24 millions; so that the maximum day's consumption was 5 millions more than they could store at any one time. If there had been at that date four or five consecutive days of fog, the Committee would have been in an awkward position, and for any failure they would have deserved the censure of the community. The Committee came to the conclusion that this position was unsafe, and so they decided to build a much larger holder, and have an excess of holder power over consuming power. Then they put down a 7 million cubic feet holder, which practically gave them a surplus of 5 millions. But during the past twelve or thirteen years, the gas business of the department had grown enormously. In 1908, their largest day's consumption had increased to 29 millions; so that they again found themselves in the position they were in in 1897—practically 5 millions short in holder power of the consumption. Hence the decision to build this holder, in the bottom of the tank trench of which they were then standing. Why did the Committee decide on such a large holder? The four 1881 holders on these works, each capable of containing 1¾ million cubic feet, cost £145,000, or £26 per 1000 cubic feet. Then they put up the 7 million cubic feet holder, which cost £11 per 1000 cubic feet, or practically half what the four cost. It would therefore be seen what an enormous gain they had in putting up one large holder rather than construct a number of smaller ones. Now they were putting up this 10 million cubic feet holder which would cost about £84,000, or equal to £8 per 1000 cubic feet of holding capacity. It would thus be seen that this huge holder would work out cheaper than ever in relation to its storage capacity. It was a gigantic undertaking. The tank work had been entrusted to Messrs. E. Nuttall and Co.; and from experience of similar work that the firm had done in the past (for the 7 million feet holder), the Committee had a right to believe that the firm would again justify the confidence in them. There was one other thing that should be said. The work was being carried out under the control, and entirely from the plans and specifications of, their own Chief Engineer (Mr. J. G. Newbigging), without any interference from anyone else. In conclusion, he said he hoped all who were present at the commencement of the work might live to see its conclusion, and that it would then be found to reflect equal credit on Engineer and Contractors alike.

Several of those present walked round the tank-trench, and were surprised at the extent of the work. Those who have knowledge of engineering structural work had much to admire in it. The clean cut of the great circular trench; and the excellent manner in which the 50 feet depth had been timbered, were objects of much interest. For the most part, the trench is in solid clay; but here and there there are faults in the strata. In one place there is a thin seam of soft coal; and as a matter of precaution headings are being driven to see there have been no workings in the neighbourhood that might in any way jeopardize the tightness of the tank. So far nothing of the kind has been discovered.

Ascending to the top of the tank again, the company left the site, just calling at the works' office to sign the visitors' book and to take some refreshment. Then, by the special tram cars, return was made to the Town Hall, where a little later Alderman Gibson presided at a dinner in celebration of the day's event. The Lord Mayor was present, as was also Alderman Rudman, of Salford; the contracting firm for the new holder tank was also represented; the members of the Gas Committee, most of the members of the Council, and the following officials had also accepted invitations: The Town Clerk (Sir William Henry Talbot), Deputy Town Clerk (Mr. Thomas Hudson), City Surveyor (Mr. T. de Courcy Meade), City Architect (Mr. Henry Price), Gas Engineer (Mr. J. G. Newbigging), Superintendent of the Gas Department (Mr. Charles Nickson), Deputy Superintendent of the Department (Mr. F. A. Price), Accountant (Mr. F. P. Smith), Chief Clerk (Mr. Thomas Vosper), Manager, Bradford Road Gas-Works (Mr. Jas. R. Hill), Deputy Manager, Bradford Road (Mr. John Taylor), Manager, Rochdale Road Gas-Works (Mr. Geo. W. Tooley), Manager, Gaythorn Gas-Works (Mr. John Merrill), Deputy Manager, Gaythorn (Mr. Fred Arnott), Manager, Droylsden Gas-Works (Mr. A. Massey), Superintendent, Street Mains Department (Mr. J. R. Brocklebank), Chemist (Mr. Evans Williams), Draughtsman (Mr. W. H. Cummins). Most of these gentlemen were present throughout the day's proceedings.

Several toasts were subsequently proposed; being introduced by the usual loyal ones, and "The Lord Mayor." Then

The LORD MAYOR proposed "Prosperity of the Manchester Gas Undertaking." He remarked that there was not a more worthy toast than that of a successful undertaking; and their gas undertaking was a most successful one. Gas was first used in Manchester in 1805; but there was a wonderful difference between the making of gas in 1805 and in 1908. And this difference was marked by the large holder of which they had seen the foundation-stone laid that day. As Alderman Gibson told them, the advantage of building these large holders was that the capital cost was reduced per 1000 cubic feet stored; and this really meant a reduced capital upon which (assuming the undertaking were a private concern) a dividend had to be made. Since 1843 when the undertaking became the property of the Corporation, the Gas Committee had had at its head men of great ability; and so there was no wonder the history of the concern had been one of continued prosperity. Whatever their opinions might be as to what they should do with their profits, the endeavour had always been that the gas undertaking should be of a profitable nature, and these men who had been at the head of affairs had always worked for the pure love of the thing, and from a desire that the business should be successful. He was not keeping out of sight the officials who had been connected with the undertaking. The breadth of view and scope of mind that had been displayed in conceiving the gigantic works of their gas undertaking were apparent on all sides. He associated with the toast the names of Alderman Gibson and the Deputy Chairman (Alderman Briggs).

Alderman GIBSON, in expressing his gratitude for the hearty manner in which the toast had been honoured, said he accepted the Lord Mayor's eulogium in the spirit in which he believed it was meant. After some further introductory remarks, he proceeded to show the enormous growth of the gas undertaking during the last twelve or fourteen years—a period contemporary with the advent and competition of electricity in Manchester. In that time there had been an increase in the consumption of gas equal to 60 per cent. In 1894, there were 82,289 customers; now there were 170,938 customers. Then they carbonized 364,895 tons of coal; last year, 527,891 tons. In 1894, they had 724 miles of mains; to-day they had 912 miles. In 1894, they were charging 2s. 6d. per 1000 cubic feet: to-day they were charging 2s. 3d.—the lowest price that had ever been charged for gas in Manchester. [A VOICE: What about the candle power?] The interruption was a rude one, but he would reply to it. It was now 17½ candles; and he found that Edinburgh this week had secured the privilege of making 14-candle power gas. In a great part of London to-day, the standard was also 14 candles. Because Manchester was the first authority to secure public lighting powers, they had no conditions placed on them; and they could make gas of any candle power they chose. They were making gas of 17½ candle power; but they did not intend to make it any less. In 1894, the Committee were receiving £14,000 for the hire of stoves and meters; to-day the stoves and meters were given free. The reduction in the price of gas from 2s. 6d. to 2s. 3d. meant £45,000 a year out of the profits of the gas undertaking. The workmen had had their wages advanced £7500 a year without asking for it. Besides all this, the undertaking in the period had contributed to the rates £741,182. Reference to "Field's Analysis" showed that the financial condition of the Manchester gas undertaking was the strongest in the Kingdom. The outstanding loan debt in 1894 was equal to 5s. 2d. per 1000 cubic feet; to-day it was 4s. 7d., as compared with an average of 7s. 9d. for ten of the largest undertakings. In 1894, the excess of assets over liabilities was £928,477; to-day it was £1,617,218, or for every £100, they had £217 with which to pay it. He had been asked questions about Sheffield and Widnes in recent times; he was content to know that in Manchester they had the biggest loaf and the biggest jar of treacle in the whole gas industry of the Kingdom.

Alderman BRIGGS, in his reply, also expressed the opinion that there was not a sounder gas undertaking in the kingdom; and he quoted several figures in support. Among them, he mentioned that the average annual consumption of gas per meter was 29,000 cubic feet.

Alderman GIBSON next proposed "The Contractors," making some complimentary remarks regarding the manner the 7 million holder tank was carried out, and expressing the opinion that Messrs. Nuttall and Co. would give an equally good account of themselves in this larger undertaking.

Mr. EDMUND NUTTALL, in responding, said as those present were aware, this was the second largest gasholder tank in the United Kingdom; but, from the contractors' point of view, there was a great deal more anxiety involved in this one than in the largest one. The latter was a shallow tank, and of much greater diameter; but it was in the depth that the responsibility came in. The one at the Bradford Road works was 50 feet deep. They had here a water pressure per square foot of 1½ tons; and so it would be recognized with what care they had to carry out the work. The whole of the bottom was porous ground; and, being in shale, with such a considerable head of water, it might, unless precautions and great care were taken, produce serious conditions. The Council, however, had a very competent staff to look after the work; and it was going to be carried out successfully. The trench was 900 feet in circumference; and those present would be pleased to hear it had been carried out without accident.

Alderman GIBSON next proposed "The Health of the Chief Superintendent (Mr. Charles Nickson) and of the Chief Engineer (Mr. J. G. Newbigging)." In the course of his eulogizing remarks, the Chairman mentioned that Mr. Nickson was not only the oldest official of the Corporation, but he was the most respected, and deservedly so. He had been for over 60 years in the service of the Corporation. During the whole of this time, he had been a true and faithful servant; and he had reaped the reward in being the chief of the largest undertaking of the Corporation. He wished to place on record the great service the Chief Superintendent had been to him (Alderman Gibson) during the fourteen years he had been Chairman. With regard to Mr. Newbigging, so satisfied had they been of the help and value of his services—his whole heart and soul and interest were centred in the work of the undertaking—that the Committee had been contented to leave the designing and carrying out of this great holder entirely in his hands. It was a great satisfaction to him (Alderman Gibson) that Mr. Nickson was still the head of the department, and that Mr. Newbigging had the confidence and support of the Committee.

Mr. NICKSON, in reply, thanked the Chairman for the kind words in which he had referred to him; and with all heartiness and sincerity, he should hand them on to his fellow officials. The officials were highly delighted to have the confidence of the Committee; and mutual confidence between members of the Committee and the officials was requisite to the well-being and success of any department of the Corporation. The members of the Gas Committee and the officials of the Department had mutual confidence the one in the other, and that was the secret of their great success. Mr. Nickson then referred to interesting incidents in the history of the undertaking which were not possibly within the knowledge of many of the younger members of the Gas Committee. He alluded to the great agitation that was once made to get the Corporation to dispose of the gas undertaking, at which time petitions were scattered broadcast for signature, and subsequently a large number of the signatures were found to be fraudulent—many having been mere repetitions, and put in at so much per thousand by those employed to get them. This attempt to get the undertaking out of the hands of the Corporation failed. He also made allusion to the difficulty that was experienced in the construction of the four gasholder tanks at the Bradford Road works. Coming to the present time, satisfactory points to which he drew attention were that, notwithstanding the higher price of coal, the price of gas had not been increased; and, having regard to the privileges the consumers enjoyed, the price he said was a fair and reasonable one, and would stand comparison with that of any other gas authority in the country.

Mr. J. G. NEWBIGGING said both he and those who laboured with him considered that it was a great honour and pleasure to work under the guidance of a Chairman who took such a keen and intelligent interest in the whole of the working of the department, and not only so, but who was scrupulously fair in all his dealings with every official from the highest to the lowest. Those present would expect him to say a few words with respect to the work so happily inaugurated that day. It was well known among gas engineers that gasholder tanks were one of the most difficult engineering structures to successfully carry through. They had to execute works of greater magnitude; but not with such difficulties to contend with as were found in gasholder tanks. The proportion of capital expenditure involved was very great; and this showed how much care should be taken in their construction, so that they should be sound and fit for use. The Chairman had explained that afternoon that the gasholder would have a capacity of 10 million cubic feet, and that it would be the largest holder in the Provinces. But it was not made that size in order to have the credit for possessing the largest sized holder out of London. The paramount reason was that they had room for a holder of this size; so that there was no use putting up one of only 7 million cubic feet capacity when they could just as readily build one of 10 million cubic feet, and make good use of it. The cost of the holder would be £83,590, or £8 0s. 7d. per 1000 cubic feet. But by a very favourable arrangement they had entered into with the contractor for brick making and for clearing the site, which the department would otherwise have had to do at their own expense, there would be a considerable saving there, which would bring the cost below the £8 per 1000 cubic feet. He ventured to say that for a structure of the type—guided to its full height, and with the market for steel not very favourable—it would be one of the cheapest in the country. From what had been seen, those present would realize how essential it was that such work should be in the hands of good and capable contractors. He hoped that all who had witnessed the laying of the foundation stone that day would be present in two years' time to celebrate the completion of the gasholder when the Chairman opened the valve to admit gas into the district for the first time. The Chairman had made a review of the progress of the undertaking. The fourteen years covered by this review had been a severe time of competition not only with electricity, but with producer and suction gas. The progress that had been made was little short of marvellous in face of competition. It showed at any rate that they had kept abreast of the times both in their works and commercially, and had taken advantage of the advances in the science and practice of the manufacture of coal gas. The manufacturing costs were now 2·41d. per 1000 cubic feet less than they were fourteen years ago, and this represented £58,000 per annum on the present make of gas. He would quote the corresponding figures for Sheffield and Widnes. In Manchester, the manufacturing charges were 4·46d. per 1000 cubic feet; in Sheffield, 6·9d.; and in Widnes, 5·36d. The Chairman was very modest in his references to the saving to the consumers in the charge for gas now as compared with the year 1894. If the consumers were at present charged meter rent and stove hire, and the same price for gas as in 1894, the extra cost to them would be about £114,000 per annum. During the fourteen years under review, the gas-works had been completely transformed; and close upon half-a-million had been spent on them; and they might with confidence say that their works would now compare favourably with any in the country. In conclusion, he said he should not be doing right if he did not acknowledge the loyal and valuable assistance he received from the whole of his colleagues working under him at the works; and he should especially on this occasion like to mention Mr. Cummins, his chief draughtsman, Mr. Hill, the Manager of the Bradford Road works, and Mr. Taylor, who was acting as Clerk of Works on this tank as he did on the other large one which proved such a great success. Without the assistance of these gentlemen, he (Mr. Newbigging) could not carry out the work so well as it was being done.

Accompanied by well-chosen expressions, Alderman RUDMAN proposed the "Health of the Chairman;" and response by Alderman GIBSON ended an evening that had proved of a very enjoyable character, and one celebrating the commencement of another notable piece of gas-engineering work.

The New Issue of Stock by the Imperial Continental Gas Association.—We learn that the whole of the new issue of £761,400 of 3½ per cent. debenture stock of the Imperial Continental Gas Association, sanctioned at the meeting of shareholders on the 15th ult. (*ante*, p. 183), has been applied for, and allotted in full, at the price of issue—viz., £92 per £100.

DISTRIBUTION OF GAS AT HIGH PRESSURE.

By M. Ch. D'Aubenton-Carafa.

[Abstract of a Paper read before the Société Technique du Gaz.]

The plant to be described was established to effect the distribution of gas in a certain number of communes situated above Lyons, on the two banks of the River Saône. The subject was investigated in 1906 when the Lyons Gas Company obtained the little works for lighting Neuville-sur-Saône, and at the same time the concession for lighting some other districts between Lyons and Neuville.

From the first, it was recognized that the old works at Neuville were in such a state that not only could they not be extended, but that they would have to be entirely rebuilt if they were to continue to make gas. The expense would have been considerable, and the net cost of gas would have been high in view of the small make. Further, the distribution of gas at ordinary pressure by extending the existing mains would have proved unsatisfactory. Neuville is more than 20 kilometres (12½ miles) from the nearest works—Perrache—and the mains at the outskirts of the Lyons district are small. The new main would, therefore, have to be taken into the centre of Lyons in order to be connected on to mains of sufficient diameter. It would, moreover, have to be of large section for the output required, and to avoid loss of pressure such as already exists in the town mains. In

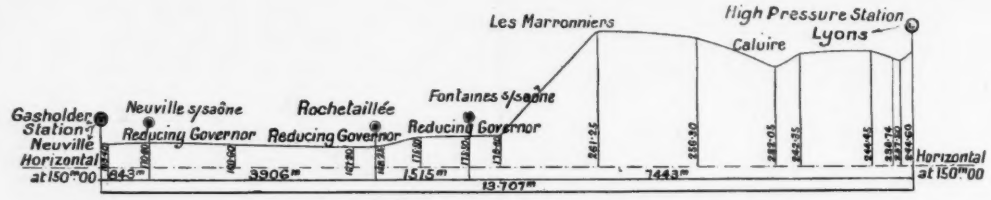


Fig. 1.—Outline of the High-Pressure Main.

consequence, first cost would be great, and, more serious still, its working would not have been satisfactory; for there would not have been any reserve, owing to the impossibility of establishing a gasholder for want of pressure to raise it. A simple obstruction would have affected the whole length; and the installation would be without any elasticity in the event of increased consumption.

All these considerations made the idea of distribution at high pressure a very attractive one. This was the solution adopted. Taking the gas from important mains in the town, it is forced by fans into a small diameter main, and at the end of this feeder into a gasholder. At each congested point is placed a reducing-governor box for the purpose of reducing the pressure to normal, and of supplying the local mains. During the "blows," the gasholder is filled while leaving enough gas for the demand *en route*. In between the "blows," the main acts as an ordinary feeder and as a return to the secondary mains.

High-Pressure Station.

The first thing was to find a suitable site for the high-pressure station. It should, while being as near as possible to the area to be supplied, be situated in a district where it will not cost too much to put up, and it should be near to mains of sufficient diameter, so as to have the amount of gas required without affecting the distribution in the neighbourhood. This site was found at La Croix-Rousse, where mains of 400 mm. and 300 mm. (16 and 12 inches) meet, and a maximum delivery of 625 cubic metres (22,073 cubic feet) was available. Here was erected a machinery room, and adjoining was a house intended for the distributing superintendent.

Besides the governors serving the surrounding district, the following plant was erected.

(1) A station meter of 250 cubic metres (8830 cubic feet) capacity per hour. Space is left for this apparatus (and all other as well) to be doubled. It is supplied by a 300 mm. (12-inch) pipe, taken off one of 500 mm. (20 inches), which is fed by the 400 mm. and 300 mm. pipes mentioned above. The size of the suction pipes, 300 mm. and 500 mm., in relation to the high-pressure main of 150 mm. (6-inch) diameter, has given every satisfaction, by compensating for the variations in pressure resulting from the working of the fans. In fact, no fluctuation is practically perceptible.

(2) A retaining flap-valve for the purpose of avoiding a return of the gas in case of a mistake in working the valves or a sudden stoppage of the fans. This valve is made of an aluminium disc, to one face of which is riveted a bevelled angle. Placed vertically in a cast-iron box, this drum is movable in the horizontal plane on a knife suspension. Round the outlet opening are cleats, 40 mm. (1⅝ inches) in height. When the fan starts, the exhausted gas pushes the disc towards the outlet and attaches it to the cleats. The gas passes without appreciable loss of pressure. In case of a return, the pressure acting contrariwise on the disc, fastens the angle against the edge of the inlet opening, which it stops up.

(3) Two sets of centrifugal fans, each made up of a Farcot fan and an electric motor. One set also has a gas-engine as a reserve. Centrifugal fans have been given the preference over piston pumps because of their simplicity of construction, small upkeep, and absence of any need of special labour. The fans are of quadruple turbine expansion 1·200 metre (3 ft. 11¼ in.) in diameter. They are made to give a pressure of about 1 metre (3 ft. 3⅜ in.) of water at 1500 revolutions.

The oiling of the bearings is done by oil under pressure, and is proportionate to the working. Independently of this, each stuffing-box is provided with a hydraulic joint of circulating water in a packed annular chamber. The water arrives at the bottom, goes round the axle, and leaves at the top of the stuffing-box, drops into a funnel, and so passes to the drain. This continuous system enables the flow of water to be regulated, and guarantees the separation of water and gas in case of leaky packing. At first, the regulation of the stuffing-boxes gave some trouble; but since it has been done, the fans have worked very regularly. They are driven directly by electric motors, which turn them by means of elastic Zodel couplings. The motors have a speed of about 1450 revolutions and develop 12-H.P.

The starting rheostats have been carefully selected, for they have to start a large bulk—about 450 kilogrammes (nearly 9 cwt.). This takes two-and-a-half minutes. Abnormal heating was at first experienced with these appliances; but they have been satisfactorily replaced.

The reserve engine is a four-cylinder vertical one of the automobile type. With petrol, it develops 18-H.P., and with coal-gas, about 12-H.P.

The suction piping is 300 mm. and 250 mm. (12 and 8 inches) in diameter, and is placed in open troughs. It is arranged to supply four fans, as the room is planned to receive ultimately a second line of fans.

The pressure piping is carried above the fans and is hung from the roof, as shown in fig. 2.

The following are the average results of several tests:—

Working with one fan:—

Speed, 1450 revolutions; delivery per hour, 242 cubic metres (8546 cubic feet); starting pressure, 985 mm. of water (38¾ inches); consumption of electric energy per cubic metre of gas sent out, 35 kw.

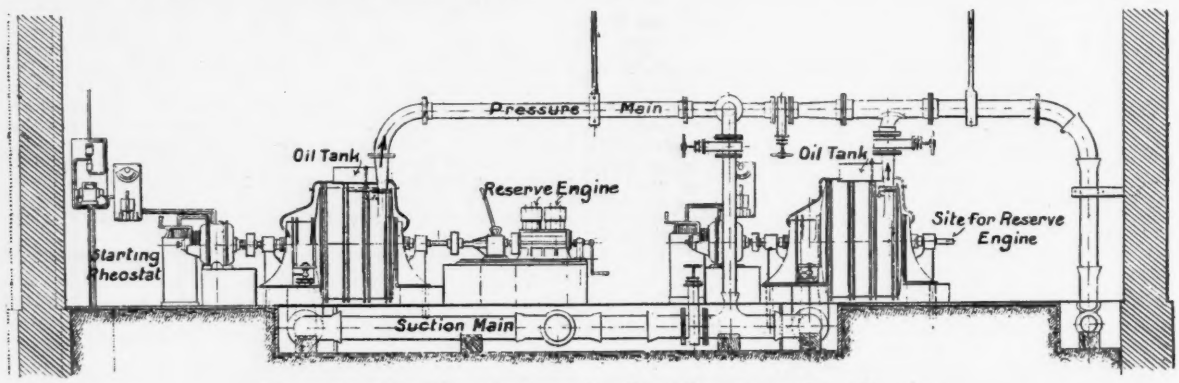
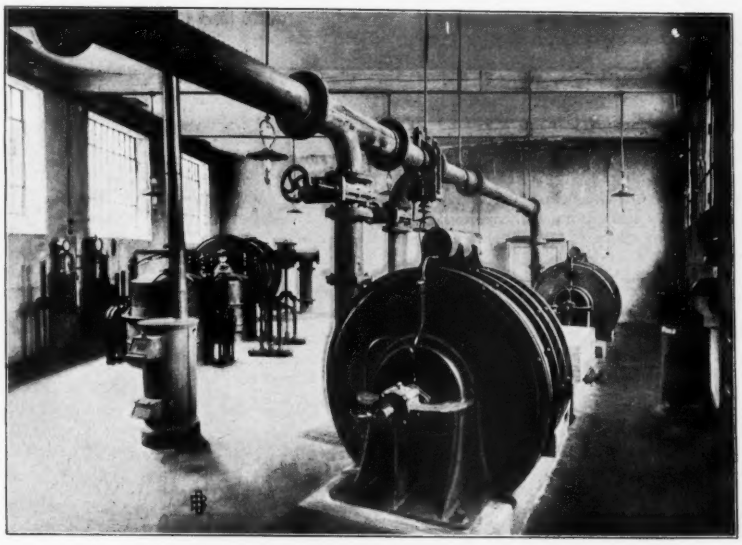


Fig. 2.—High-Pressure Machine Room—Two Farcot Fans of 1·200 Metres Diameter.

Working together :—

Speed of the two fans, 1450 revolutions; delivery per hour, 405 cubic metres (14,303 cubic feet); starting pressure, 1910 mm. of water (6 ft. 3¼ in.); consumption of electrical energy per cubic metre of gas sent out, 45 kw.

The working together of the two fans will be exceptional, and will be limited to a few hours of maximum consumption in the year. We give the figures here merely to show the elasticity there is in the working of this plant.

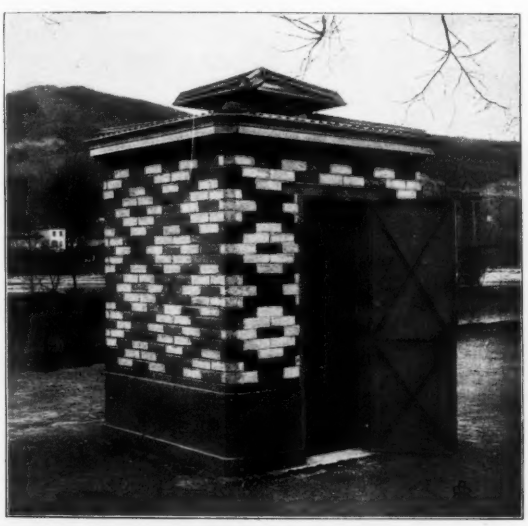


General View of the Pressure Plant.

Feeding Main.

The feeding main starts from the machinery room first described and finishes at the gasholder station at Neuville. It is 13 kilometres 700 metres long (about 8½ miles). To fix its diameter, the probable maximum consumption was estimated, and was found to be about 400 cubic metres (14,130 cubic feet). The diameter adopted was 150 millimetres (6 inches) up to the reducing governor in the centre of Neuville, or for a length of 12,864 metres. After that, the diameter is 200 millimetres (8 inches). This was because the main in between the "blows" will serve as an ordinary pressure main; and it is better to have the larger main between the gasholder and the first important centre of consumption.

The main was laid at an average depth of 1 metre (3 ft. 3⅜ in.); and we endeavoured to have long straight lengths and to avoid sharp changes of direction. Only bends



The Cabin containing the Reducing Governors on the Feeding Main at Rochetaillée.

of $\frac{1}{16}$ and $\frac{1}{32}$ were used. Further, to avoid the risk of accidents from heavy traffic, the main was laid under the pavement and the side of the roads. Its profile is rather uneven. Starting at a level of 244 metres, it reaches, 5 kilometres further on, its highest point at 260 metres, and then falls to 170 metres at Fontaines, at the level of the banks of the Saône. The joints of the pipe are in india-rubber; and every 300 metres there are arrangements for facilitating the testing of the main in sections, and for examination and repairs. Besides the tests made during the work of laying, three general tests were made when it was finished. The pressure of 340 mm. (13⅜ inches) of mercury, or 4·600 metres (over 15 feet) of water was maintained without giving way for 24 hours. In May, 1907, when the main was in use, a final test on the whole length was made; and the pressure of 354 millimetres (14 inches) of mercury or 4·810 metres (about 15 ft. 9 in.) of water was maintained intact for 37 hours.

The main is provided with special wells or syphons with a constant water-seal to prevent any loss of gas, even after pumping out. It is composed of two round reservoirs; and the general details of it will be understood from fig. 3. The height between the foot of the tube and the bottom of the smaller reservoir is 2 metres (6 ft. 6¾ in.), which forms a seal equal to the maximum pressure in the main.

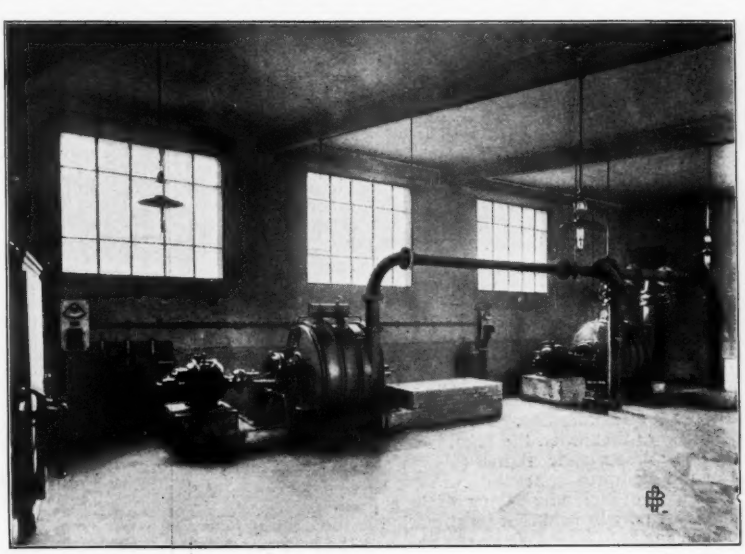
This long feeding main and the opportunity we have had of varying the output and the pressures have enabled us to make some interesting experiments on the loss of charge. The following table gives the comparisons between the pressures taken experimentally and those calculated according to the formulæ of tables of Arson and of Monnier—taking into account, of course, the static differences in pressure due to altitude.

	Output: 245 Cubic Metres.			Output: 355 Cubic Metres.		
	Loss of Charge.			Loss of Charge.		
	As Found.	As Calculated. Monnier.	As Calculated. Arson.	As Found.	As Calculated. Monnier.	As Calculated. Arson.
	Metres.	Metres.	Metres	Metres	Metres.	Metres.
From the pressure station to Fontaines; 7443 metres. Static loss, 52 mm.	0·490	0·541	0·895	0·940	1·078	1·727
From the pressure station to Rochetaillée; 8958 metres. Static loss, 57 mm.	0·590	0·645	1·072	1·130	1·292	2·073
From the pressure station to Neuville; 12,864 metres. Static loss, 56 mm.	0·840	0·900	1·513	1·660	1·829	2·949

Arson's tables, therefore, are not applicable to the high pressures used; while those of Monnier give near results when these pressures do not exceed 1 metre of water. Beyond this, the indications they give deviate considerably from the actual pressures.

Gasholder Station.

The gasholder station erected at Neuville, on the land of the old gas-works, consists of a two-lift telescopic holder of 1200 cubic metres (42,380 cubic feet) capacity. The pressure of the first lift



The Centrifugal Fans.

is 140 mm. of water, and of the second lift, 200 mm. The tank is built above the ground, and is in reinforced concrete.

At the station, the feeding main divides into two branches corresponding to the two valves of the gasholder. On one of them is an outlet governor with mercury seal, corresponding to the maximum pressure (2 metres of water), which closes as soon as the action of the fans makes itself felt. It only allows the gas to pass when the pressure in the main falls below that for which it is regulated—that is, slightly lower than the pressure given by the gasholder. On the other branch is placed a valve worked automatically by the gasholder, and closing itself when the holder is 100 or 200 mm. (4 or 8 inches) above the point when it unseals. As the result of this arrangement, if the fans continue to work when the gasholder is full, the valve shuts itself in turn, and the delivery being then cut off, the high-pressure station is notified that they must stop pumping. When the pressure falls in the feeder, in consequence of demands on the secondary mains, the bell of the governor is lowered and the gas is allowed to pass. The gasholder emptying itself, opens the automatic valve, thus giving the feeding main its full pressure. Fig. 4 shows the method of working the valve automatically.

Reducing Governors.

Reducing governors are placed on branches coming from the feeding main so as to distribute the gas locally at normal pressure, whatever it may be higher up. They are placed in little cabins or boxes on the roadway. Each has two cone governors, placed alongside one another and provided with a mercury seal. The arrangement of pipes and valves enables either one or the other apparatus to be used or the whole to be bye-passed. A safety valve is connected with them. It consists of a vessel filled with an uncongealable liquid, and communicates with the air. A pipe, which is connected to the outlet of the system, plunges into the liquid. In case of faulty working, the seal of the dip-pipe allows a sufficient outlet to prevent the pressure becoming dangerous in the distributing mains. (See fig. 5.)

The reduction of pressure of the gas is effected in steps, passing in the first governor from the feeder pressure to that of 140 mm.

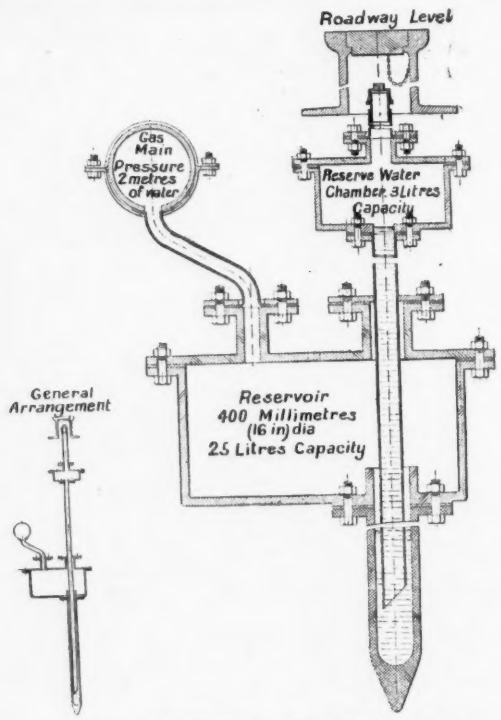

Roadway Level
Gas Main Pressure 2 metres of water
Reserve Water Chamber 3 Litres Capacity
General Arrangement
Reservoir 400 Millimetres (16 in) dia 25 Litres Capacity

Fig. 3.—Automatic Water-Sealed Draining-Well.

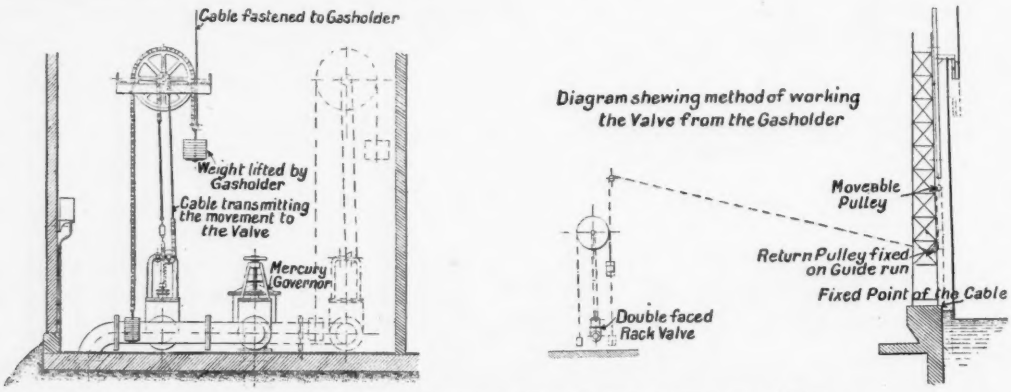

Cable fastened to Gasholder
Weight lifted by Gasholder
Cable transmitting the movement to the Valve
Mercury Governor
Diagram shewing method of working the Valve from the Gasholder
Moveable Pulley
Return Pulley fixed on Guide run
Fixed Point of the Cable
Double faced Rack Valve

Fig. 4.—Outlet Governor and Gasholder Inlet Valve Worked from the Gasholder.

(5½ inches), the limit of pressure which can be withstood by the consumers' meters. The second apparatus reduces it to 60 or 80 mm. (2·36 or 3·15 inches) according to local requirements. The safety valve is regulated to 120 mm. (4¾ inches), so as to come into play if the second governor is out of order. The first is thus kept as a rampart between the feeder and the distributing mains. In addition, oscillations are marked on the pressure indicators in the boxes, and give warning to the staff. The working of the reducing governors has been perfect.

These boxes have, of course, been placed as centrally as possible to the districts to be supplied, which are on both sides of the River Saône; the districts being connected by suspension bridges. The crossing of these bridges was rather difficult, owing to the flexibility of their roadway, due to their span of 160 metres (about 175 yards). The first one put up is now being tried, and, if satisfactory, the same method will be adopted on other bridges.

Our distribution of gas has, therefore, only extended to the left bank of the river, where the feeding main is laid. The governors have been put up at Neuville, Rochetaillée, and Fontaines, at distances of 850, 4750, and 6250 metres from the gasholder. They are certain in the future to control the supply of the districts on the other side of the Saône. The secondary mains to-day amount to 15 kilometres (9½ miles); but they will ultimately extend to 30 or 35 kilometres (19 to 22 miles).

Under these conditions, any information as to the actual cost of the high-pressure installation would not be of interest, as the situation is a transitory one. But the experience of the past few months shows that when the plant reaches its annual output of about one million cubic metres (say, 35 million cubic feet), the cost of the high-pressure system will not reach one centime per cubic metre, not including paying off the capital.

Finally, it may be said that no alteration in the lighting power of the gas has been observed as the result of the high pressure; and the condensation in the syphon-pots, after several analyses, has not shown any trace of benzene.

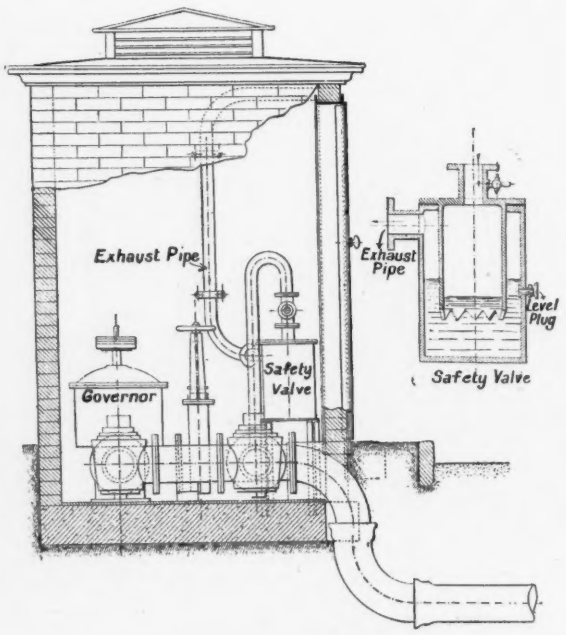


Fig. 5.—Reducing Governor-Box and Safety-Valve.

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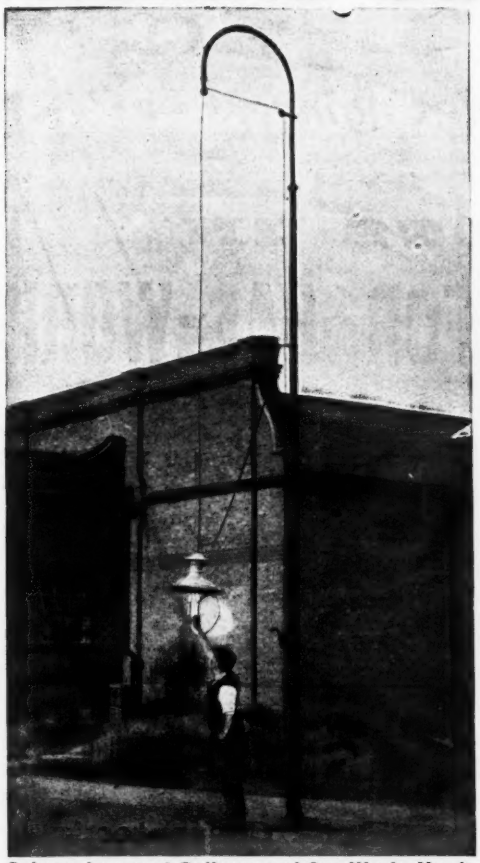

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See "Gas Journal," Jan. 22, 1907, p. 216; "Gas World," Jan. 26, 1907, p. 115.

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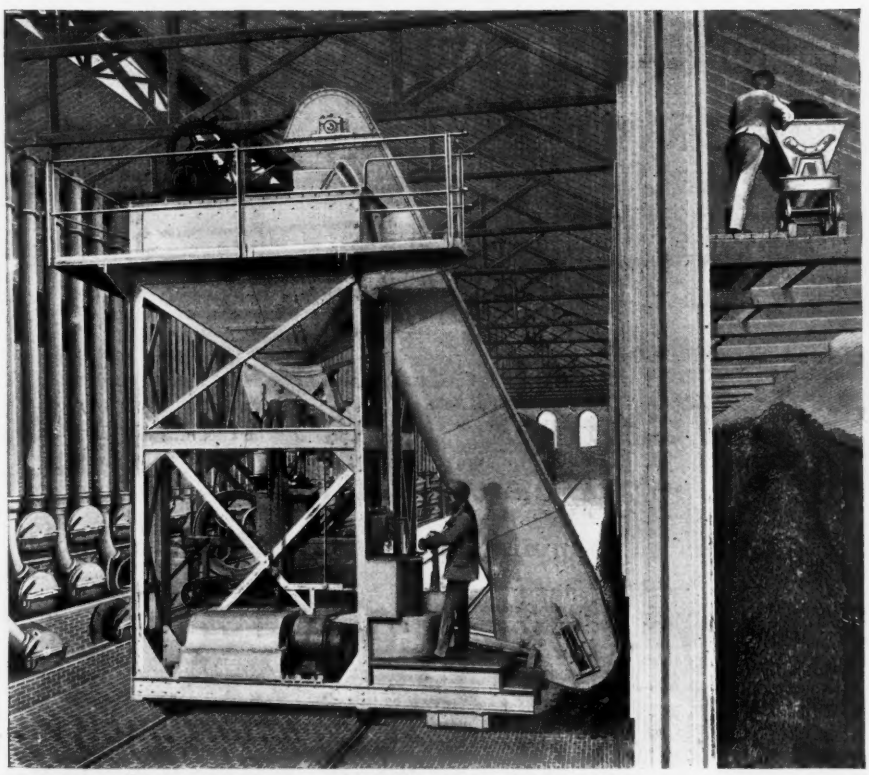

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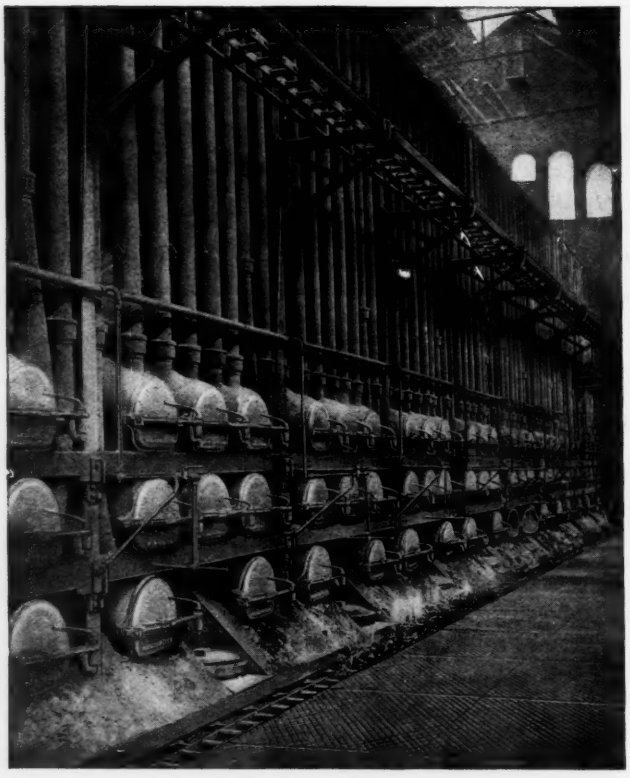

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THE COMBUSTION AND THERMAL DECOMPOSITION OF HYDROCARBONS.

Revised Text of a Lecture by Professor William A. Bone, Ph.D., D.Sc., F.R.S., of Leeds University, delivered before the Institution of Gas Engineers, June 17.

The course of the oxidation of hydrocarbons and the ways in which they are decomposed at high temperatures have always been regarded as questions of the greatest importance in connection with the manufacture and applications of coal gas; and therefore I need offer no apology for availing myself of this opportunity of directing your attention to some recent advances in this branch of chemical science.

It is now exactly a century since those distinguished Manchester chemists, John Dalton and William Henry, showed that both marsh gas (methane) and olefiant gas (ethylene) yield twice their own volume of hydrogen, with simultaneous liberation of carbon, under the continuous action of electric sparks [Dalton's "New System of Chemical Philosophy," Part I. (1808), pp. 440, 447, and Phil. Trans. Roy. Soc., 1809, p. 446]. Of still greater interest to us are Dalton's classical experiments upon the partial combustion of the two hydrocarbons in which mixtures of each gas with its own volume of oxygen were separately exploded in a glass eudiometer over mercury (see Table I.). In the case of methane, the whole of the carbon was burned to carbonic

TABLE I.—*Dalton's Experiments.*

A.

100 CH_4 100 O_2	yielded	100 CO 100 H_2	and H_2O, but no carbon.
200 vols.		200 vols.	

B.

100 C_2H_4 100 O_2	yielded	10 CO_2 175 CO 175 H_2	no H_2O, no carbon.
200 vols.		360 vols.	

oxide, and as nearly as possible half of the hydrogen to steam. The cold products occupied the same volume as the original mixture, and consisted of carbonic oxide and hydrogen in equal proportions. In other words, the initial and final states of the system could be expressed by the equation—

$$CH_4 + O_2 = CO + H_2 + H_2O.$$

In the corresponding experiment with ethylene, there was neither any separation of carbon nor condensation of steam; the cold products occupied nearly twice the volume of the original mixture, and consisted mainly of carbonic oxide and hydrogen, in accordance with the equation—

$$C_2H_4 + O_2 = 2CO + 2H_2.$$

Experiment.—I will now repeat Dalton's experiments in a slightly modified form. The two explosive mixtures of each hydrocarbon with its own volume of oxygen are sealed up in these borosilicate glass bulbs provided with suitable firing wires. Each mixture will now be fired by means of an electric spark. You will observe that in neither case is there the slightest separation of carbon. In the case of the methane experiment, there is an abundant condensation of moisture, but none at all in the ethylene bulb. The gaseous products in each case consist almost entirely of carbonic oxide and hydrogen.

It is important, however, to observe that Dalton did not attempt to draw any definite conclusion as to the real mechanism of the combustion. He merely regarded the mixture of carbonic oxide and hydrogen obtained from ethylene as an "intermediate state," and was content with recording the fact that "one-third of the oxygen requisite for complete combustion suffices to convert the carbon into carbonic oxide, and the hydrogen is at the instant liberated; hence the other two-thirds are employed, the one to convert the carbonic oxide into acid, the other to convert the hydrogen into water."

A few years later, Dalton's illustrious contemporary, Sir Humphrey Davy, in the course of his wonderful investigations on "Flame," made the far-reaching discovery that combustible gases combine with oxygen at temperatures considerably below their ignition points without any appearance of flame whatever. He emphasized the importance of a complete investigation of the chemical aspects of this flameless combustion, and was led to ask himself whether, seeing that the temperature of flames far exceed those at which solids become incandescent, a metallic wire can be raised to incandescence by the slow combustion of two gases "without actual flame, but producing heat enough to keep the wire ignited." In this way he discovered the remarkable property of platinum and other metallic wires of inducing surface combustion, and in the course of his further experiments he made two notable observations concerning the burning of gases containing carbon and hydrogen. He found "much carbonic oxide" produced when a platinum wire was kept incandescent by the slow combustion of a mixture of ethylene and oxygen, rendered non-explosive by an excess of the hydrocarbon. In a similar experiment with ether vapour—$C_4H_{10}O$—he recorded the appearance of "a pale phosphorescent light" accompanied by "the formation of a peculiar acrid volatile substance possessed of acid properties."

It is to Davy, also, that we owe the first explanation of the cause of luminosity of hydrocarbon flames, which has since given rise to so much controversy. He was "led to imagine" that it "might be due to the *decomposition* of part of the gas towards the interior of the flame where the air was in smaller quantity, and the deposition of solid charcoal, which, first by its *ignition*, and afterwards by its *combustion*, increased in a high degree the intensity of the light." It is clear, therefore, that Davy rightly attributed the luminosity to the separation of minute particles of solid carbon as the result of thermal decompositions in the interior of the flame. He avoided the error, which prevailed in later years, of ascribing the separation of carbon to a supposed preferential burning of hydrogen.

Important as were these early experiments, it is in no sense a reflection upon the genius of either Dalton or Davy to say that they could have had but little idea of the complexity of hydrocarbon combustion or the modes of separation of carbon in flames. Comparatively little was known in their day concerning the factors which govern the course of chemical changes in gaseous systems, and it required the labours of at least two succeeding generations of chemists and physicists before the consequences of the molecular theory of gases, foreshadowed by the new conceptions introduced by Dalton, Davy, Guy Lussac, Avogadro, Berthollet, and others, during the early years of the last century, could be fully realized and applied in practice. Moreover, at that time, only two hydrocarbons were known; now they are counted by hundreds, and classified into a few well-defined series in accordance with certain characteristic chemical properties. It is indeed a singular fact that while carbon and hydrogen in the free state combine only with great difficulty, even at the highest temperature of the electric arc, no other pair of elements can exhibit anything like the same wonderful range or variety of combinations.

That the ultimate resolution of a hydrocarbon into its elements at high temperatures cannot be regarded in general as the immediate result of a single chemical change was proved by Marchand in 1839, when he transformed ethylene into (mainly) carbon and methane by passing it through a red-hot porcelain tube packed with fragments of the same material. At a still higher temperature, with a packing of either copper or iron wire, the gas ultimately yielded little else than carbon and hydrogen. Marchand concluded from these observations that the decomposition of ethylene involves a primary change into carbon and methane,

$$C_2H_4 = C + CH_4,$$

followed by a secondary resolution of the methane into its elements. It is interesting to note that he applied his discovery to the preparation of a gas for large balloons by passing ordinary coal gas through red-hot iron tubes or retorts packed with iron wire. By this means, he succeeded in reducing the density of Berlin gas from 0·43 to 0·21.

It is to that distinguished French chemist, Berthelot, whose brilliant pioneering researches on the action of heat upon hydrocarbons were published during the years 1865-9 ("Annales de chimie et de physique"), that we owe the first really adequate and comprehensive experimental treatment of the subject. By this time a large number of new hydrocarbons, including representatives of all the more important groups now recognized, had been discovered, and the way thus prepared for a general pronouncement upon

their relative stabilities and interactions at high temperatures, and Berthelot, with his remarkable genius for marshalling the results of a long and rapidly executed series of experiments, was singularly well fitted to the task of constructing a general theory.

Berthelot was strongly opposed to the idea that a hydrocarbon is ever *directly* resolved into its elements under the influence of heat, or, indeed, that the primary change ever involves the separation of carbon at all. On the contrary, he contended that at all temperatures the process of decomposition is essentially and in the main a continuous coalescence of hydrocarbon molecules, with elimination of hydrogen at almost every stage, until at length carbon appears as the final result of the decomposition of an extremely dense molecular aggregation. The chief factor in bringing about such a sequence of changes was, he supposed, the primary formation of acetylene and its marked disposition to polymeric changes. This hydrocarbon had been isolated by Edmund Davy in 1836, and named by him "*klumene*." But so little did he investigate its properties, that its existence was soon forgotten. It was re-discovered by Berthelot in 1859 as a product of the thermal decomposition of ethylene, ethyl-alcohol, wood-spirit, and other organic compounds, and he at once submitted it to a thorough investigation. Amongst other important observations, he effected its synthesis by forming the electric arc between carbon poles in an atmosphere of hydrogen, thereby demonstrating its stability at the highest temperatures obtainable; he also discovered its rapid polymerization to benzene and styrolene at incipient red heat. On the strength of these facts, he assigned to acetylene a position of altogether exceptional importance in relation to pyrogenetic changes in hydrocarbon systems. He referred to it as "le produit ultime des decompositions pyrogenées . . . generateur fondamental des carbures pyrogenées."

On the diagram before you (Table II.) are represented Berthelot's views as to the modes of decomposition of some of the simpler hydrocarbons. He believed that methane is primarily converted into either (*a*) ethane and hydrogen, or (*b*) acetylene and hydrogen, by the coalescence of two molecules. Ethane, he supposed, yields either (*a*) ethylene and hydrogen, or (*b*) acetylene, methane, and hydrogen. Ethylene, in like manner, yields either (*a*) acetylene and hydrogen, or (*b*) acetylene and ethane. Of the two alternative modes (*a*) and (*b*), he considered (*b*) to be the more probable and frequent. Thus, it will be seen that each of the three hydrocarbons would, either initially or as a secondary effect, give rise to large quantities of acetylene together with hydrogen.

TABLE II.—*Berthelot on the Decomposition of Methane, Ethane, and Ethylene.*

Methane	(*a*) $2CH_4 = C_2H_6 + H_2$.
	(*b*) $2CH_4 = C_2H_2 + 3H_2$.
Ethane	(*a*) $C_2H_6 = C_2H_4 + H_2$.
	(*b*) $2C_2H_6 = C_2H_2 + 2CH_4 + H_2$.
Ethylene	(*a*) $C_2H_4 = C_2H_2 + H_2$.
	(*b*) $2C_2H_4 = C_2H_2 + C_2H_6$.

According to Berthelot, the acetylene thus produced rapidly polymerizes to benzene, which in turn coalesces with more acetylene forming styrolene, naphthalene, anthracene, &c., in the manner indicated in Table III.

Continuing the same line of reasoning, Berthelot supposed that it is by the further mutual coalitions of such dense hydrocarbon molecules, with the elimination of hydrogen at each successive stage, and in no other way, that carbon is at length obtained.

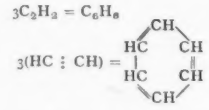
In connection with the experimental side of the inquiry, Berthelot succeeded in convincing himself that the long series of changes involved in the decomposition of any particular hydrocarbon may be resolved into a series of single reactions, which are either all individually reversible, or which may be grouped so as to comprise a number of reversible cycles. Hence he concluded that, in consequence of the operation of the law of mass, there would be established at each particular temperature a complex state of equilibrium between hydrogen, methane, ethane, ethylene, acetylene, benzene, styrolene, diphenyl, naphthalene, anthracene, ... and carbon. No adequate quantitative proof of the establishment of any such state of equilibrium was ever advanced, and so far as I am able to judge, the idea is quite opposed to the experience of all subsequent investigators.

I have dwelt on Berthelot's views at some length, not only on account of their historic interest, but because they raise a question which has long been in dispute, namely, the

TABLE III.—*Berthelot on the Formation of Aromatic Hydrocarbons from Acetylene.*

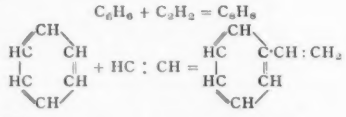
(1) Benzene.

$$3C_2H_2 = C_6H_6$$



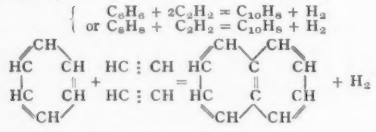
(2) Styrolene.

$$C_6H_6 + C_2H_2 = C_8H_8$$



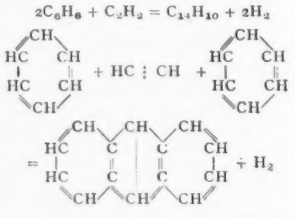
(3) Naphthalene.

$$\begin{cases} C_6H_6 + 2C_2H_2 = C_{10}H_8 + H_2 \\ \text{or } C_6H_6 + C_2H_2 = C_{10}H_8 + H_2 \end{cases}$$



(4) Anthracene.

$$2C_6H_6 + C_2H_2 = C_{14}H_{10} + 2H_2$$



relative importance of acetylene as a factor in these thermal decompositions.

Within recent years Professor Vivian B. Lewes has put forward a new version of the "acetylene" theory in connection with his well-known views respecting the luminosity of hydrocarbon flames [Trans. Chem. Soc., 69 (1892), p. 322; Proc. Roy. Soc., 55 (1894), 90; 57 (1805), 394, 450]. He agrees with Berthelot in regarding acetylene as a principal and primary product of the decomposition of both methane and ethylene, and as responsible for the formation of aromatic hydrocarbons; but, unlike Berthelot, he considers it capable in an eminent degree of direct decomposition into its elements at high temperature with (owing to its endothermic character) explosive effect. He believes that in the inner zone of a coal-gas flame the hydrocarbons are broken down by radiant heat from the outer envelope, yielding acetylene, which at the still higher temperature of the luminous region is resolved into carbon and hydrogen, the liberated carbon particles being raised to a much higher temperature than that of the surrounding flame, consequent upon the sudden disengagement of the energy originally locked up within the molecules of the acetylene decomposed.

Lewes represents the primary decomposition of methane by the equation—

$$2CH_4 = C_2H_2 + 3H_2;$$

whilst ethylene, he argues, is primarily converted into equal volumes of acetylene and methane, as follows:—

$$3C_2H_4 = 2C_2H_2 + 2CH_4,$$

and that the acetylene subsequently either polymerizes, yielding aromatic hydrocarbons, or is resolved into its elements, according to the degree of temperature.

Whilst I am not aware that Lewes's theory of the luminosity of flames has met with much acceptance among chemists, and especially on the part of those who are most entitled to speak from a first-hand knowledge of the facts, it may be profitable to examine for a moment the claims of acetylene to be considered as an all-important factor in hydrocarbon decompositions. It cannot be denied that, at a moderately high temperature, acetylene polymerizes, forming aromatic hydrocarbons; nor would anyone, I suppose, dispute the proposition that at still higher temperatures it is directly resolved into its elements. But if it be claimed that these properties are peculiar to acetylene and its homologues, or that acetylene is necessarily a prime and principal product of the decomposition of other hydrocarbons, then I am prepared to join issue with any such theory.

Many years ago, Professor T. E. Thorpe and Mr. John Young (Proc. Roy. Soc., 1873, **21**, p. 184), in investigating the combined action of heat and pressure upon certain constituents of shale oil, concluded that the higher paraffins are primarily decomposed into an olefine and a lower

paraffin. Thus, they supposed that butane would primarily yield ethane and ethylene, in accordance with the equation:

$$C_4H_{10} = C_2H_6 + C_2H_4.$$

Then again, Professor H. E. Armstrong and Dr. A. K. Miller, in the course of an exhaustive examination of the products of the manufacture of "oil gas" from petroleum [Trans. Chem. Soc., 1886, **49**, p. 74], found considerable quantities of ethylene and normal olefines of the type $C_nH_{2n+1}CH:CH_2$ (up to and including *n* heptylene), as well as of benzene and other aromatic hydrocarbons, but they drew particular attention to the almost entire absence of acetylene and its homologues.

Finally, Professor Haber, of Karlsruhe, in a paper dealing with the decomposition of *n* hexane, C_6H_{14}, in which he vigorously assailed the theories of both Berthelot and Lewes, proved that at temperatures between 600° and 800° C. the hydrocarbon is decomposed, without liberation of either carbon or hydrogen, yielding much methane and the olefine C_5H_{10} (amylene), but no acetylene, as follows:—

$$CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3 = CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH{:}CH_2 + CH_4$$

It would appear, therefore, that acetylene is not a prime product of the decomposition of the higher paraffins, and my own experience with methane and ethane would lead me to extend the conclusion to the lower members of the series also.

I have recently carried out, in conjunction with Mr. H. F. Coward, M.Sc. of the Manchester University, an investigation of the decomposition of the four hydrocarbons—methane, ethane, ethylene, and acetylene—at temperatures between 500° and 1150° C., which has led us to conclusions differing in many important respects from those of previous workers, and I will endeavour to briefly lay them before you.*

In an investigation of this kind, it is necessary that the influences of at least three important factors—namely, temperature, time, and the surface exposed to the gas—shall be carefully studied before any conclusion can be legitimately drawn as to the real course and mechanism of the decomposition. Moreover, it is essential that each gas shall be examined in a state of purity, and that the temperature and other physical factors shall be under perfect control.

The experimental method adopted consisted either in continuously circulating a considerable volume of the gas under investigation at a constant rate through a jacketed porcelain tube, heated in a gas-furnace to the desired experimental temperature for several hours, in an apparatus similar to that used in my previous researches on gaseous combustion [*vide* Phil. Trans. Roy. Soc., 1906, A., p. 9], or in shutting up the gas in the porcelain tube for definite time intervals, suitable arrangements being made for the determining of the pressure in the apparatus at any moment during an experiment.

In considering the principal results of the investigation, I wish first of all to draw attention to the relatively high stability of methane, the influence of surface upon its decomposition, and the character of the carbon obtained from it, as well as to its large formation during the breaking-down of the other three hydrocarbons.

Up to the highest temperature examined (1150° C.) the decomposition of methane is entirely a surface phenomenon—that is to say, the gas only decomposes in contact with the walls of the heated chamber or with any solid that it may contain. It is obvious, therefore, that the rate of decomposition will depend on three factors, namely: (1) the amount of surface exposed to the gas, (2) the temperature, and (3) the concentration of the gas. In our experiments, 800° C. was the temperature at which the rate of decomposition assumed appreciable magnitude when the heated tube was used without any solid packing, and under such conditions only about 4½ per cent. of the original gas was decomposed in an hour. On raising the temperature, the rate of decomposition naturally increased. At 1000° about one-third, and at 1150° about 80 per cent. of the original gas disappeared within an hour. So much, then, for the influence of temperature.

The dependence of the decomposition upon the surface exposed to the gas may be judged by comparing the rates observed in two experiments at 1000°, in the first of which the heated tube was used without any solid packing, while in the second it was packed with fragments of quicklime. In the first experiment only 35 per cent. of the original gas decomposed in an hour, while in the second no less than 96 per cent. disappeared within 25 minutes. In fact, the packing of the tube with quicklime accelerated the rate of decomposition far more than did the raising of the temperature from 1000° to 1150° These results are set forth in Table IV.

TABLE IV.—*Decomposition of Methane in Porcelain Tubes.*

Composition of the Gas after One Hour.

Temperature.	800°.	1015°.	1150°.
Acetylene	Nil.	Nil.	Nil.
Methane	91·6	48·2	9·15
Hydrogen	8·4	51·8	90·85
Per cent. of original gas decomposed	4·4	35·0	83·3

Influence of Surface.—Tube packed with Quicklime. At 1000°, 96 per cent. of the original gas decomposed in 25 minutes.

The moral of these results is, of course, obvious. Methane is one of the most valuable heating constituents of coal gas, having a *net* calorific value nearly 65 per cent. greater than that of the hydrogen obtained by its decomposition. Therefore it should be the object of the gas manager to, as far as possible, preserve the methane intact during the carbonizing process. Now it is not so much temperature in the main body of the gas as contact with hot surfaces which decomposes methane, and therefore the amount of surface in proportion to the rate of gas evolution should be reduced to the smallest limits consistent with complete and effective carbonization.

Experiment.—The character of the decomposition as a surface-effect is shown by the following experiment which Mr. Coward has been good enough to prepare for us. The apparatus consists of two porcelain tubes, A and B, heated side by side in a powerful gas-furnace to a temperature of more than 1000° C. The tubes are connected with the same supply of methane in the gasholder, and also each one communicates with a separate mercury manometer reading against a paper scale. One of the tubes, A, is packed with quicklime, the other, B, contains no packing. Both tubes are now being rapidly exhausted by means of this Geryk air-pump. The exhaustion is now complete. By turning the tap leading to the gasholder, Mr. Coward will admit the methane at the same instant into both the tubes, and immediately afterwards he will cut off the connection with the holder, leaving the tubes each open to its own manometer only. The tubes are now each full of methane at the same (atmospheric) pressure. The rate of decomposition of the methane in the two tubes may be judged by the rate of increase in the pressure, as indicated by the manometers, since methane on decomposition yields carbon and twice its own volume of hydrogen. You will observe how very much faster the pressure rises in the tube A, which is packed with quicklime, than in the unpacked tube B—a sure criterion of a faster rate of decomposition. The striking difference in the two rates is a fact which should be ever-present in the minds of gas managers, since it is proof positive of the great influence of hot surfaces on the decomposition of this most valuable constituent of coal gas.

I now come to a point of considerable interest to all those engaged in carbonizing work—namely the character of the carbon deposited on a hot surface by methane in active decomposition. Nothing has been more remarkable in our experiments than the difference between the carbon obtained from methane and that derived from the other three hydrocarbons. Carbon from methane is deposited on the hot surface in a peculiarly hard and lustrous (almost "metallic") condition, utterly unlike the dull and soft variety obtained when the other three hydrocarbons are decomposed throughout their mass by radiant heat from the hot walls of the containing vessel. One is almost tempted to ask whether the surface decomposition of methane is not mainly responsible for the "gas carbon" found in the crown of your retorts, as well as in part for the characteristic metallic lustre of the coke obtained in coke-ovens where very high temperatures prevail. The point seems well worth further investigation.

The question may now be asked—Does methane decompose *directly* into carbon and hydrogen, or does it primarily yield acetylene and hydrogen, in accordance with the theories of Berthelot and Lewes? We have given special attention to this point during our investigation, and are decidedly of opinion that the decomposition is mainly, if not entirely, a direct one. The reasons for this view are twofold—namely, (1) The striking difference between the carbon that

* The results of the investigation are described in greater detail in the Trans. Chem. Soc., 1908, Vol. XCIII., pp. 1197-1225.

is yielded by methane and acetylene respectively at high temperatures, which one would certainly not expect to find if the carbon from methane arose merely as the result of the secondary decomposition of acetylene, and (2) the fact that acetylene is all but absent from the decomposition products of methane at any stage of the process, and entirely so if the methane is sufficiently diluted with, say, hydrogen or nitrogen.

If the rate of decomposition of undiluted methane at any particular temperature be closely studied, it will be found that during a short interval after the admission of the gas into the hot vacuous chamber, the rate is proportional to some high power of the methane concentration. This initially high rate, however, rapidly and continuously falls off, until it at length assumes a value which is steadily proportional to the first power of the methane concentration. Largely increasing the surface exposed to the gas, by packing the tube with a solid material, whilst it accelerates the rate as a whole, shortens the initial period of exceptionally fast decomposition, and hurries on the moment when the rate assumes its steady value proportional to the methane concentration. It is only during the initial phase of the process, which seems to involve an active decomposition in highly condensed layers of gas newly formed at the hot surface, that traces of acetylene and aromatic hydrocarbons can be detected in the products. Afterwards, when the surface layers become attenuated by reason of the outward rush of hydrogen and the simultaneous diminution in the methane concentration, normal decomposition of methane into its elements proceeds to the practical exclusion of the more complex process (whatever it may be), and the formation of acetylene and its polymerized products ceases.

Passing on now to the consideration of the modes of decomposition of the other three hydrocarbons, it may be at once said that we no longer have to do with a mere surface effect, as was the case with methane, but one which is produced throughout the whole body of the gas by heat radiated from the walls of the enclosing chamber. The general character of the process can best be judged from the results obtained at fairly low temperatures, where the velocity of decomposition is slow enough to admit of the observations being extended over many minutes or hours together. Moreover, since under the experimental conditions the rate of decomposition of methane is inappreciable at temperatures below about 800° C., the selection of a lower temperature had the advantage of preserving intact any methane produced.

The first set of results to which I would draw your attention are those obtained with ethane at 675° C., with the apparatus arranged for a "circulation" experiment. (Table V.)

TABLE V.—*Decomposition of Ethane at* 675° C.

Original pressure in apparatus = 248 mm.

Time [Hours.]	½.	1½.	3.	6.
P_2/P_1.*	1·47	1·70	1·80	1·87
Acetylene	4·1	5·1	2·8	1·9
Ethylene	24·7	24·1	16·4	0·7
Ethane	34·7	9·8	7·3	2·0
Methane	8·4	19·9	32·9	54·5
Hydrogen	28·1	41·1	40·6	40·9

* P_2/P_1 = Ratio of final to initial pressure in the apparatus.

Liquid and Solid Products:—

[1.] About 45 per cent. of the carbon deposited.

[2.] Naphthalene about 4 per cent. of the weight of the original gas.

The decomposition of the hydrocarbon was, as you will observe, extended over six hours, during which the pressure in the apparatus increased by 87 per cent. It is obvious, from the composition of the gases at intermediate periods, that during the earlier stages of the experiment, the ethane was principally converted into ethylene and hydrogen, while during the later stages methane and carbon were prominently formed, apparently at the expense of ethylene. At no period during the experiment was there any large formation of acetylene—that is to say, large in comparison with the other products. About 45 per cent. of the carbon originally present in the gas was deposited during the experiment, and a small quantity of almost pure naphthalene, equivalent to about 4 per cent. of the weight of the original gas, condensed in the cold connections outside the heated tube. Curiously enough, practically no benzene was formed. The original ethane had *apparently* (I use the term advisedly) been primarily resolved into ethylene and hydrogen, with subsequent secondary conversion of the ethylene into carbon and methane, in accordance with the scheme—

$$C_2H_6 = C_2H_4 + H_2 = C + CH_4 + H_2.$$

This plausible theory, however, hardly fits in with the following set of results obtained at 800° (Table VI.):—

TABLE VI.—*Decomposition of Ethane at* 800° C.

Time (Minutes.)	1.	5.	15.	30.	60.
Acetylene	1·90	1·20	0·50	Trace	*Nil*
Ethylene	11·20	4·40	0·75	*Nil*	*Nil*
Ethane	17·90	2·40	*Nil*	*Nil*	*Nil*
Methane	31·30	54·55	64·65	66·0	63·75
Hydrogen	37·70	37·45	34·10	34·0	36·25
Ratio CH_4/H_2	0·83	1·46	1·90	1·94	1·75
Condensable products	Small amount.		Practically none.		

In this experiment, the "circulation" method was not employed, the gas being simply shut up in the heated tube for definite time intervals, up to 60 minutes, and then withdrawn. It will be seen that, as at the lower temperature, considerable quantities of ethylene were initially produced, but the ratio of methane to hydrogen in the products increased from 0·83 at the end of a minute to no less than 1·94 at the end of half an hour. This fact is quite inconsistent with the equation just referred to, or indeed with any simple equation which can be proposed, and for a long time we were quite unable to arrive at any satisfactory explanation of it. The amounts of aromatic hydrocarbons produced were very small, and the relatively insignificant quantities of acetylene observed in the products entirely dispose of the view that this hydrocarbon is either a primary product of or plays any conspicuous part during the decomposition process.

Passing on now to the case of ethylene, about which so much has been written, we will first of all consider a set of results obtained with the "circulation" apparatus at a temperature of 575° C., the observation being extended over 2½ hours. In Table VII. are recorded the total pressures in the apparatus, the partial pressures of the different gases, and the units of carbon in the gases, at the end of each successive time interval.

TABLE VII.—*Decomposition of Ethylene at* 575° C.

Initial pressure = 365 mm. = 730 units of carbon.

Time (Minutes.)	2.	15.	30.	45.	60.	75.	150.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Ethylene	272·5	177·0	143·0	120·0	104·5	94·0	83·5
Acetylene	43·0	26·5	20·5	22·5	26·5	31·0	23·0
Ethane	12·8	28·7	29·7	29·4	27·3	24·0	9·9
Methane	16·1	54·6	67·5	77·1	90·0	95·6	132·8
Hydrogen	17·9	72·9	93·1	101·0	102·0	97·4	93·0
Total pressure mm.	362·5	359·0	354	351	350	342	342
Units of carbon in the gases	672·7	519·0	454	421	406	393	365
Ratio CH_4/H_2	0·9	0·75	0·72	0·76	0·9	0·98	1·43

Amount of Carbon Deposited: Less than 1 per cent. of that originally present in the gas. *Tarry Vapours:* Large formation.

The outward character of the decomposition was very different from that observed with ethane. In the first place, the pressure in the apparatus fell slightly, instead of increasing largely, during the experiment, and the course of chemical change was marked by the continuous expulsion from the hot tube of heavy vapours which condensed to a brown tarry mass. There was, however, practically no deposition of carbon. Acetylene was prominently formed, and much of it polymerized, whilst there was a continuous accumulation of methane throughout the whole experiment. There was also a certain tendency to form ethane by a direct hydrogenation of part of the ethylene.

It will be evident to those who will carefully study these results, as it was to us who actually witnessed the experiment, that acetylene is probably a primary product of the decomposition of ethylene. A moment's further consideration will, however, show that the large accumulation of hydrogen without a corresponding separation of carbon at once disposes of Lewes's contention that the main decomposition may be represented by the equation—

$$3C_2H_4 = 2C_2H_2 + 2CH_4,$$

which would imply that any hydrogen formed must arise from the secondary resolution of the acetylene into its

elements, since methane is perfectly stable at this temperature. Moreover, the absence of free carbon in the products is inconsistent with Marchand's equation,

$$C_2H_4 = C + CH_4.$$

The next set of results, at a temperature of 800° (Table VIII.), shows much the same general characteristics, with certain significant differences.

TABLE VIII.—*Decomposition of Ethylene at* 800° C.

Time (Minutes.)	1.	5.	15.	30.
Acetylene	3·00	3·90	3·85	*Nil*
Ethylene	57·25	21·40	9·65	0·9
Ethane	3·25	5·00	1·30	*Nil*
Methane	29·40	53·40	64·45	67·7
Hydrogen	7·10	17·00	20·75	21·4
Ratio CH_4/H_2	4·14	3·1	3·1	2·1

Pressure.—Small increase (750 to 790 mm.) during the first 5 minutes; afterwards remaining constant.

Much more carbon separated and less aromatic hydrocarbons formed than at 575°.

There was very little change in pressure (if anything a slight increase) during the experiment. Much more carbon was deposited and less aromatic hydrocarbons formed than at the lower temperature. But perhaps the most striking feature is the large accumulation of methane, which at the end of the experiment constituted rather more than two-thirds of the gaseous products.

Experiment.—I have arranged the following experiment to illustrate the outward difference between the decomposition of ethylene at incipient red heat and at an almost white heat respectively. Here are two porcelain tubes, electrically heated throughout almost their whole length, the one to about 750°, and the other to over 1100°. One end of each tube communicates with this gasholder containing ethylene, the other end is attached to a glass condensing worm. The tubes and their connections are being exhausted, and are now quite vacuous. On opening the tap leading to the gasholder, the gas enters the vacuous tubes, and is now passing through them in a slow and regular stream. What I want you to observe is the difference in the appearance of the two condensing worms. The worm attached to the low temperature tube is full of a whitish mist which rapidly condenses to a yellowish liquid (aromatic hydrocarbons). From the high temperature tube, on the other hand, there issues a black cloud of finely divided carbon together with other tarry vapours. It is obvious, therefore, that a low temperature favours the formation of aromatic hydrocarbons, whilst at high temperatures the acetylene primarily produced is largely resolved into its elements.

I will now direct your attention to the behaviour of the last, and in some respects the most interesting, of the four hydrocarbons—namely, acetylene. This gas possesses many remarkable properties, due to its unsaturated and strongly endothermic character, and prominent among these are its power of polymerizing to benzene at moderately high temperatures, its great instability at a somewhat higher range of temperature—in the neighbourhood of 900° to 1000°—and lastly its almost paradoxical stability at the highest temperature of the electric arc. Moreover, owing to the fact that it is formed in minute quantities in the thermal decompositions of nearly all other hydrocarbons, it has acquired a great reputation among chemists as a high-temperature product, although some of us think that its importance has been greatly over-estimated in this connection, to the detriment of true knowledge.

The tendency of acetylene to polymerize is probably at its maximum between 600° and 700°. In the following "circulation" experiment at 650° (Table IX.) the pressure in the apparatus fell from 510 mm. to 154 mm. in the course of 8½ hours, during which brown vapours of aromatic hydrocarbon were continually expelled from the hot tube. Practically 60 per cent. of the original acetylene polymerized during the experiment, and another 35 per cent. decomposed in other ways, a small portion being "hydrogenized" to ethylene and ethane respectively. It is interesting to note that the residual gas contained as much as 30 per cent. of methane, the mode of formation of which will be discussed later.

As the temperature rises above 700°, the tendency for the gas to polymerize rapidly decreases, and the direct decomposition into carbon and hydrogen increases, until at 800° or thereabouts, the latter becomes so marked that the gas

TABLE IX.—*Decomposition of Acetylene at* 650°.

Time (Hours)	0	1	2	3	4	5	6	8½
Pressure (mm.)	510	333	249	200	180	172	168	154.

Residual Gas.

—	11 m.m.	Per Cent.
C_2H_2	19	12·0
C_2H_4	15	10·0
C_2H_6	2	1·3
CH_4	45	30·0
H_2	70	46·7

Weight of original acetylene = 2·59 grams.
Weight of polymerized products = 1·56 grams.
Weight of carbon obtained = 0·55 grams.

bursts into vivid incandescence when suddenly admitted into the hot vacuous tube, owing to the strongly exothermic character of the main chemical change. This luminous decomposition of acetylene, if I may use a convenient but somewhat loose expression to designate a striking visual effect, has been investigated by Lewes, who contends that it is essentially the cause of the luminosity of hydrocarbon flames. Professor Haber has, indeed, doubted whether pure acetylene, free from traces of oxygen (air), does really exhibit this luminous decomposition. I feel bound to say, however, that our experience confirms Lewes's statement of the fact, much as we dissent from his theory of the luminosity of hydrocarbon flames.

Experiment.—I will now proceed to demonstrate this so-called luminous decomposition of acetylene, as follows. We have here a quartz tube, about 9 inches long, heated over this arrangement of six bunsen burners. The tube is connected through a stop-cock with this small holder containing acetylene. The tube and its connections are now being exhausted by means of a Geryk air-pump capable of reducing the pressure to less than a millimetre of mercury. The exhaustion is now complete. I will now open the tap leading to the holder. You will observe the bright flash which is produced when the gas enters the hot vacuous tube, and if a current of the gas be now passed through the tube, you will notice that it bursts into incandescence as soon as it comes within the heated zone.

The next set of results (Table X.) refers to an experiment made at 800°, in which pure acetylene was shut up in the hot tube for definite time intervals. In each case a momentary brilliant flash was observed on admitting the gas into the hot vacuous tube, and for a fraction of a second the temperature of the system must have been far higher than that recorded by the pyrometer. It is instructive, however, to observe that at the end of one minute—long after the flash had subsided—there still remained as much as 25 per cent. of acetylene in the gases. Polymerized products were certainly present during the first few minutes, but they eventually disappeared after prolonged heating.

TABLE X.—*Decomposition of Acetylene at* 800°.

Time (Minutes).	1.	5.	15.	60.
Acetylene	25·90	7·3	1.35	*Nil*
Ethylene	4·20	2·7	*Nil*	*Nil*
Ethane	2·65	0·7	*Nil*	*Nil*
Methane	15·00	35·3	37·65	43·0
Hydrogen	52·25	54 0	61·00	57·0
Ratio CH_4/H_2	0·3	0·65	0·6	0·75

By far the most important feature in this experiment was the large formation of methane, especially during the quiet decomposition which supervened after the "flashing" had subsided, and when the atmosphere was rich in hydrogen. The final products, after 60 minutes, contained no less than 43 per cent. of methane, a fact which is not easily explained by any theory yet put forward.

Hitherto I have not spoken about the influence of temperatures higher than 800° C., except in the case of methane, chiefly because the rates of decomposition of the other three hydrocarbons are so extraordinarily rapid that very little more information can be derived as to the nature of the primary changes concerned. Not one of the three hydrocarbons can survive for more than about five minutes at a temperature of 1000° to 1200°, so that, except in so far as secondary changes were concerned, the usefulness of the time-method was practically exhausted. Nevertheless the following results obtained for each of the three hydro-

carbons at temperatures of 1000° and 1150° C. respectively are of interest in that they give some idea of the very large quantities of methane produced:—

TABLE XI.—*Experiments at* 1000°.

—	Ethane.		Ethylene.		Acetylene.	
Time (Minutes).	1.	5.	1.	5.	1.	5.
Acetylene	2·5	0·55	3·50	0·35	13·85	1·85
Ethylene	6·9	1·80	8·70	1·65	2·05	0·35
Ethane	5·5	1·15	*Nil*	*Nil*	*Nil*	*Nil*
Methane	32·6	41·95	54·75	48·35	19·10	20·65
Hydrogen	52·5	54·55	33·10	49·65	65·00	77·80

Experiments at 1150°.

Acetylene	—	Trace	—	0·50	—	0·3
Ethylene	—	*Nil*	—	1·75	—	*Nil*
Methane	—	27·0	—	25·20	—	21·3
Hydrogen	—	73·0	—	72·55	—	78·4

So far, I have contented myself with a review of the more important facts brought to light during the course of the investigation, and with pointing out how, in certain particulars, they are inconsistent with nearly all the theories so far advanced. We entered upon the investigation with the avowed object of obtaining crucial data whereby the good among existing theories might be sorted out from the bad. But the more we proceeded, the more were we convinced that, so far as ethane, ethylene, and acetylene are concerned, no one theory was capable of explaining all the characteristic features of their decompositions. The chief difficulty was to explain the very large quantities of methane formed, more especially in the experiments at 800°, a difficulty which for a long time seemed unsurmountable. At last an idea occurred to us which happily solved the riddle, and which, I believe, provides the true explanation of the whole of the chemical phenomena. A critical examination of the mass of evidence accumulated during the investigation persuaded us that the difficulty referred to arose because we, in common with other preceding workers, had looked upon methane as one of the immediate products of the collapse of the hydrocarbon molecule, and that it would only disappear with the recognition of methane as being formed by the direct "hydrogenation" of one of the initial products. These initial products might be unsaturated "residues," such as $\cdot CH_3$, $: CH_2$, or $\vdots CH$, which in an atmosphere rich in hydrogen would probably be readily converted into methane. The internal evidence of the experiments, especially of those at 800°, clearly indicated the necessity of some such hypothesis. We have, therefore, advanced the following theory.

In the case of ethane and ethylene, it may be supposed that the primary effect of high temperature is mainly to cause elimination of hydrogen, with a simultaneous loosening or dissolution (according to the temperature) of the bond or bonds between the two carbon atoms. In the event of actual dissolution occurring, there would arise "residues" such as $:CH_2$ and $\vdots CH$, which it may be supposed have a very fugitive separate existence in the decomposing medium. These "residues" would, however, speedily either (*a*) form $H_2C : CH_2$ and $HC \vdots CH$ (*i.e.*, ethylene and acetylene) as the result of encounters with other like "residues," or (*b*) break down directly into carbon and hydrogen, or (*c*) be "hydrogenized" to methane in an atmosphere already rich in hydrogen. These three possibilities may all be realized simultaneously in the same decomposing gas in proportions depending on the temperature and the amount of hydrogen present. The idea is summarized in the following scheme:—

$$\underset{\text{Ethane.}}{H\cdot\dot{C}\cdot\dot{C}\cdot H} = \left[2(:CH_2) + H_2\right] = \begin{cases}(a)\ C_2H_4 + H_2.\\ (b)\ 2C + 2H_2 + H_2.\\ (c)\ \textit{plus}\ H_2 = 2CH_4.\end{cases}$$

$$\underset{\text{Ethylene.}}{\dot{C} : \dot{C}} = \left[2(\vdots CH) + H_2\right] = \begin{cases}(a)\ C_2H_2 + H_2.\\ (b)\ 2C + H_2 + H_2.\\ (c)\ \textit{plus}\ 2H_2 = 2CH_4.\end{cases}$$

In the case of acetylene, the main primary change may be either one of polymerization or of dissolution, according to the temperature, and, if the latter, it may be supposed that the molecule collapses, giving rise to $\vdots CH$ residues, which are subsequently either (*a*) resolved into carbon and hydrogen, or (*b*) "hydrogenized" to methane, according to the temperature and the proportion of hydrogen present—

$$\underset{\text{Acetylene}}{HC \vdots CH} = \left[2(\vdots CH)\right] = \begin{cases}(a)\ 2C + H_2\\ (b)\ \textit{plus}\ 3H_2 = 2CH_4\end{cases}$$

↓

Polymerizes to benzene at low temperature.

Having thus arrived at a theory which seemed capable of explaining the observed facts, it remained to confirm it by some direct proof of the actual formation of methane in the manner alleged. If, as we suppose, hydrogen is directly active in producing methane, it necessarily follows that unmistakable evidence of the fact should be afforded by comparative experiments in which each of the three hydrocarbons, respectively, is diluted to the same degree with (*a*) nitrogen, and (*b*) hydrogen, provided that the temperature is favourable to the preservation of methane and yet sufficiently high to effect the rapid decomposition of the original hydrocarbon. Accordingly, several series of comparative experiments were carried out, in which each hydrocarbon, diluted with three times its own volume of (*a*) nitrogen and (*b*) hydrogen, was maintained in the hot tube at 800° for an hour (a sufficiently long time to decompose the whole of the original hydrocarbon, without appreciably destroying any of the methane formed from it). The percentages of methane in the resulting gaseous products, which are set forth in Table XII., confirms the theory we have put forward as to its formation by the direct "hydrogenation" of unsaturated residues.

TABLE XII.—*Dilution Experiments at* 800°. *Time, One Hour.*

	Original Mixture.	Methane per Cent. in the Products.
Ethane	$C_2H_6 + 3N_2$	18·00
	$C_2H_6 + 3H_2$	41·25
Ethylene	$C_2H_4 + 3N_2$	13·80
	$C_2H_4 + 3H_2$	43·50
Acetylene	$C_2H_2 + 3N_2$	5·65
	$C_2H_2 + 3H_2$	27·80

Having dealt so fully with the question of the thermal decomposition of hydrocarbons, the time at my disposal does not permit of my giving more than a very brief account of their combustion. I am fortunately able, with the help of Dr. Julien Drugman, who formerly collaborated with me in Manchester on this subject, to show you a number of experiments illustrating some of the more important features of hydrocarbon combustion.

Some of you are probably familiar with the historic aspects of the long controversy which has been waged concerning the precise way in which oxygen attacks a hydrocarbon molecule at high temperatures. A hydrocarbon, as its name denotes, contains the two combustible elements, carbon and hydrogen, and although in a sufficient supply of oxygen these are burned to, ultimately, carbon dioxide and steam, respectively, this is but the final result of a complex process which probably involves several well-defined intermediate stages.

During the greater part of last century the majority of chemists believed hydrogen to be the more combustible of the two elements in a hydrocarbon, although this view is manifestly inconsistent with the early experiments of Dalton, upon the partial combustion of methane and ethylene, which I showed you at the beginning of the lecture. As the result of the important investigations upon flames and explosions carried out within recent years by Professor Harold B. Dixon and Professor Smithells, Dalton's facts were re-discovered, and the old view was abandoned in favour of the idea that, in hydrocarbon combustion, the carbon is preferentially burnt. It is clear that this constituted a complete revolution of opinion on the matter.

But there were some chemists who steadfastly refused to accept the idea of preferential burning, whether of carbon or hydrogen, as something repugnant to well-established principles concerning the nature and conditions of chemical interchanges in gaseous systems. Many years ago, indeed, Professor H. E. Armstrong suggested that the combustion of a hydrocarbon takes place under the conjoint influence of water and oxygen, and involves the successive formation of intermediate hydroxylated molecules, which at the high temperatures of flames at once decompose into simpler products capable of further independent oxidation. Little notice was at the time taken of this suggestion, but my own researches on the subject prove that such intermediate hydroxylated molecules are probably formed, even in flames, although I doubt whether water vapour is an essential factor in their

formation—preferring to regard the oxygen as being directly active.

The differences between the three theories may be represented by reference to the explosion of a mixture of equal volumes of ethylene and oxygen, as follows:—

(1) According to the old view that hydrogen is preferentially burned, the products of explosion should consist of carbon and steam, in accordance with the equation—

$$C_2H_4 + O_2 = 2C + 2H_2O.$$

(2) According to the opposite view—viz., that carbon is preferentially burned—the products should be (as they actually are) carbonic oxide and hydrogen, as follows:—

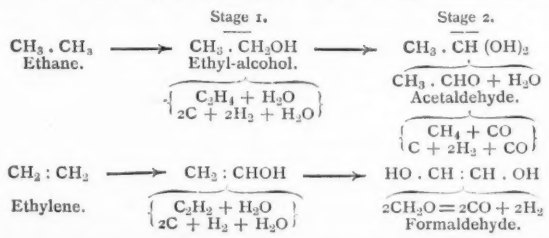
$$C_2H_4 + O_2 = 2CO + 2H_2.$$

(3) Whereas, according to the third theory, the carbonic oxide and hydrogen do not arise *directly* as the result of the initial encounter between the hydrocarbon and oxygen molecules, but *indirectly* by the breaking down of an "oxygenated" molecule, such as $C_2H_4O_2$, thus—

$$C_2H_4 + O_2 = [C_2H_4O_2] = 2CO + 2H_2.$$

Obviously, therefore, the well-known behaviour of the mixture of equal volumes of ethylene and oxygen, although it disproves the first theory, is not crucial as between the second and third.

A long series of experiments upon the slow combustion of ethane and ethylene at temperatures below their ignition points led me to formulate the following schemes as representing their explosive combustion, the underlying idea being that the oxygen initially enters the hydrocarbon molecule, forming an unstable hydroxylated molecule, which at once either decomposes into simple products, or is further oxidized to the dihydroxy stage, when decomposition occurs.



So great, however, is the affinity between the hydrocarbon and oxygen at high temperature that I assume that in a supply of oxygen sufficient to carry the oxidation as far as the second stage, no decomposition of the mono-hydroxy molecule formed at the first stage occurs. This especially applies to the case of an unsaturated hydrocarbon, such as ethylene or acetylene, and in the absence of the retarding influence of the cold walls of the containing vessel. But, in the event of the supply of oxygen being insufficient to complete the second stage, more or less breaking down at the first stage must occur.

It will be at once evident that the behaviour of a mixture of equal volumes of ethane and oxygen on explosion should be crucial as between my theory and that of the preferential burning of carbon; for whereas, according to my view, the resulting products should consist of carbon, methane, hydrogen, steam, and carbonic oxide, according to the other theory, they should consist of nothing but carbonic oxide and hydrogen, thus—

$$C_2H_6 + O_2 = 2CO + 3H_2.$$

In other words, one volume of the original mixture should yield two-and-a-half volumes of carbonic oxide and hydrogen. If the pressures of the original mixture (p_1) and that of the final products (p_2), at constant volume, be taken as the basis of comparison, the ratio p_2/p_1 should be 2·5, according to the theory of the preferential burning of carbon, but a considerably lower value according to my theory. We will now make the experiment.

Experiment.—The mixture of equal volumes of ethane and oxygen has been previously sealed up in one of these borosilicate glass bulbs. The bulb has a capacity of 60 c.c. and is fitted with firing-wires. The mixture will now be fired by passing an electric spark through it. You will observe that a lurid flame fills the vessel accompanied by a black cloud of carbon particles, and a close inspection of the bulb will reveal considerable condensation of steam. (The bulb was here handed to Dr. Harold G. Colman, who confirmed the formation of water.) The pressure ratio p_2/p_1 is only 1·5 (as compared with the 2·5 required by the theory of the preferential combustion of carbon), and an analysis of the residual gaseous products would reveal the presence of about 10 per cent. of methane. The theory of the preferential combustion of carbon is manifestly inconsistent with the results of this simple experiment. Had time permitted, it would have been easy for me to demonstrate to you the formation of aldehydic products in this experiment, but I must ask you to take this for granted. I will, however, direct your attention to the detailed results of a similar experiment carried out some time ago in my laboratory, which are set forth in Table XIII., and will ask you to compare it with the results similarly obtained with a mixture of equal volumes of ethylene and oxygen.

TABLE XIII.—*Results of Experiments on Inflammation in Sealed Glass Bulbs.*

Original Mixture.	Ethane and Oxygen. $C_2H_6 + O_2$.			Ethylene and Oxygen. $C_2H_4 + O_2$.		
p_1	746 mm.			545 mm.		
p_2	1148 ,,			1053 ,,		
p_2/p_1	1·54			1·93		
CO_2	4·20			0·30		
CO	33·55			50 00		
$C_2H_2 + C_2H_4$	2·75			Nil.		
CH_4	10·85			1·70		
H_2	48·60			48·00		
	C.	H.	O.	C.	H.	O.
Units in original mixture	746	1119	376	545	545	272
Units in gaseous products	621	854	241	547	541	267
Difference	125	265	135	Practically nil.		
Remarks	Carbon deposited. Steam condensed.			No carbon deposited. No steam condensed.		

Experiment.—Further insight into the mechanism of the combustion of this hydrocarbon (ethane) is gained by comparing the effects of different rates of cooling upon the composition of the products, when a flame traverses the equimolecular mixture $C_2H_6 + O_2$. This may be accomplished by firing the mixture in two glass vessels having the same volumes but different surface areas. For this purpose I have selected (1) a glass tube about 1 metre long and 2 cm. internal diameter, and (2) a globe of 8·5 cm. internal diameter. The surface exposed to the gases in the case of the tube is about three times as great as in the case of the globe. It is, therefore, to be expected that the more rapid cooling of the flame will cause a greater accumulation of the primary or earlier products of combustion in the case of the tube experiment, so that the method affords a convenient means of discriminating between the character of the earlier products and those which mainly arise as the result of secondary processes at a later stage. The contents of each vessel will now be fired by means of an electric spark. You will observe that the flame traverses the long tube at a rate which can easily be followed by the eye. The strong cooling action of the glass walls is inimical to the long continuance of high temperature in the exploded gases, and reduces the effects of secondary changes to a minimum. From the outward appearance of the tube, it is evident that very little carbon has separated during the combustion. Indeed the transparency of the tube is very little diminished; but its inner surface is thoroughly wetted with the water which has condensed from the cold products. In the case of the globe, however, where the effects of cooling have been much less, there is a very large separation of carbon, so large indeed that it is impossible to see through the globe even when a strong light is placed behind it, and the condensation of steam, although still discernible, is less than in the tube experiment.

If time permitted of my following up the result of these two experiments with pressure records and analyses of the gaseous products, it would be seen that the pressure ratio p_2/p_1 was only 1·45 in the tube experiment as against 1·75 with the globe, and that the larger separation of carbon in the latter case was chiefly due to the more complete breaking down of the unsaturated hydrocarbons, ethylene and acetylene, in the flame. It would also be found that there has been a much greater survival of aldehydic products in the case of the tube than in the globe experiment.

All these observations point to the fact that unsaturated hydrocarbons, water, and aldehydic products arise at an earlier stage in the combustion than does carbon—a result which is quite consistent with the theory I have put forward. Table XIV. gives the results of two similar experiments carried out some time ago in my laboratory :—

TABLE XIV.—*Inflammation of an Equimolecular Mixture of Ethane and Oxygen.*

		A. In Long Tube.			B. In Large Globe.		
p_1		701 mm.			685 mm.		
p_2		1018 ,,			1187 ,,		
p_2/p_1		1·45			1·73		
Per cent. Composition of gaseous products.	CO_2	4·20			3·40		
	CO	34·80			36·10		
	C_2H_2	5·00	7·65		0·15		
	C_2H_4	2·65					
	CH_4	8·85			7·25		
	H_2	44·50			53·05		
		C.	H.	O.	C.	H.	O.
Units in original mixture		694	1041	354	678	1017	346
Units in gaseous products		643	738	220	558	805	255
Difference		51	303	134	120	212	91
Per cent. difference		7·6	29	37·8	18	20	27·5

Experiment.—My last experiment is designed to illustrate the infinitely greater affinity of a hydrocarbon, such as ethylene, compared with that of hydrogen for oxygen at the high temperatures of flames. I have here a bulb containing a mixture of equal volumes of ethylene, hydrogen, and oxygen, corresponding to $C_2H_4 + H_2 + O_2$, and I want you to contrast the behaviour of this mixture with that of the equimolecular mixture of ethane and oxygen, $C_2H_6 + O_2$, exploded in a similar bulb a few minutes ago. I would remind you that whilst the two mixtures contain the same relative proportions of carbon, hydrogen, and oxygen, they differ in respect of the proportions between the combined (*i.e.*, "hydrocarbon") carbon and hydrogen. I will now fire the mixture of ethylene, hydrogen, and oxygen. You will observe that there is absolutely no deposition of carbon; the bulb is as clear and transparent as it was before the mixture was fired. Moreover, a close inspection of the cold bulb will reveal no condensation of steam, so that any formation of steam during the combustion has been insufficient to saturate the cold products. The hydrocarbon has, in fact, been burned to carbonic oxide and hydrogen, leaving the original hydrogen practically untouched. The detailed results of this remarkable experiment are shown in Table XV.

TABLE XV.—*Experiment on the Inflammation of the Mixture* $C_2H_4 + H_2 + O_2$.

$p_1 = 503$ mm.
$p_2 = 750$,,
$p_2/p_1 = 1·49$

Gaseous Products
$CO_2 = 0·35$, $CO = 39·60$, $C_2H_2 + C_2H_4 = 1·25$, $CH_4 = 3·65$, $H_2 = 55·15$ per cent.

	C.	H.	O.
Units in original mixture	341	505	168
Units in gaseous products	346	478	151

This experiment has an important bearing upon the chemistry of flames. Hitherto it has been usual to regard hydrogen as one of the most combustible of gases; but here we see it pushed to one side, in the competition for oxygen, by the all-powerful hydrocarbon, as though it was so much inert nitrogen. Did time and other circumstances permit, I could easily demonstrate to you the infinitely superior affinity of other olefines, as well as of acetylene, over that of hydrogen for oxygen at high temperatures, and I am now investigating whether methane and the other paraffins may be placed in the same category in this respect as the unsaturated hydrocarbons.

To deal adequately with the subject of hydrocarbon combustion would need a whole course of experimental lectures, and I am reluctantly compelled to take leave of you, as it were, at the very threshold of the subject. I trust, however, that I have in some measure succeeded in bringing home to you an idea of the complexity of the combustion process, and the vast and attractive field of enquiry which it opens out. Theories will come, and have their day, and disappear, but to increase of knowledge there is no end. It may truly be said that not only are the theoretical issues involved in the systematic study of gaseous combustion absorbingly interesting to those who, like myself, spend a large part of their time in scientific investigation, but that a true understanding of the successive stages in combustion is essential to the attainment of that perfection in the various applications of coal gas after which all of you are daily striving.

MAINTENANCE AND REPAIR OF GAS-METERS.

At the last Annual Meeting of the Wisconsin Gas Association, a paper on the above subject was read by Mr. E. S. DICKEY, the Treasurer of the Maryland Meter Company, of Baltimore. The following are some extracts from the communication.

In taking up the subject-matter for discussion under this heading, it might be well to note the great variety of opinions existing among different gas engineers, managers, and superintendents of distribution as to how a meter should be maintained in order to secure the greatest efficiency from the apparatus. The matter of maintenance is one the importance of which is ofttimes overlooked, not merely in respect to the gas-meter, but to almost any property. The owner of real estate in the form of dwellings or business houses may fail to provide the necessary maintenance for his property, with the result that sooner or later he will find a very marked depreciation in value. We can readily grasp and appreciate the necessity of repainting a dwelling; and in similar manner we can understand the necessity for the proper maintenance of machinery. The proper maintenance of a gas-meter, however, does not present the same situation. The gas company buy a meter, and, to the smaller companies especially, who are lacking the facilities of a regularly-equipped meter-repair department, this meter represents a sealed book so far as any inspection of its actual working parts may be concerned. The question very aptly comes up: How can a piece of apparatus such as a gas-meter adapt itself to any exterior condition which might assist in its maintenance—in other words, adapt itself to exterior conditions which would assist in its regular work, with the ultimate result of either increasing its efficiency or lengthening its term of service? While it appears that with apparatus of this class exterior conditions would not materially affect the meter itself, yet general experience has proved that proper maintenance of a meter is to a great extent controlled by exterior conditions.

In the first place, a meter purchased new, coming to the gas company from the manufacturer, is assumed to be correct in respect to registration, and is assumed to be in good working order, ready for immediate installation without inspection or test by the purchaser. These assumptions of accuracy and reliability are practically correct; and, referring as they do more particularly to the interior mechanism of the meter, they are generally applicable to meters of any reputable manufacturer. But there are exterior conditions also entering at this point. Meters purchased are sometimes subject to rough handling in transport, which may occasionally cause breakage of the interior parts. But, as above stated, these occasions are rare. There is one point, however, which should be closely watched in respect to the condition of new meters when received—viz., the condition of the paint used on the outside for protective purposes. If this paint has been scratched in transport, exposing the bright plate, the meters should be repainted or touched up before being set in service. A second item comes directly under the superintendent of distribution or the superintendent of the meter department, in respect to the handling of meters by the street gang in transporting them to the various consumers' premises. There was a time when the average fitter or waggon man assumed that meters could be thrown promiscuously into the waggon—top, bottom, or side up—and carted as so much junk over rough streets. But it is very gratifying to be able now to say that a condition of this nature has become an exception. Meters should be carried at all times with the top up, should be handled carefully, and, if loaded on a waggon for transport through streets, should be separated either by a pad or by rag, waste, or other similar soft substitute.

This approaches the question of the setting of the meter on the service line; and at this point considerable care should be taken as to the place selected. A gas-meter should not be set in a damp place; it should not be hung too near a damp wall; nor yet should it be in too close proximity to the heating plant in the building. Every fitter employed by a gas company should be ordered to see that all joints are gas-tight before leaving a job as finished on the consumers' premises; but at the same time he should be cautioned not to use a wrench designed for a 6-inch union on a 1-inch meter connection, as excessive strain on unions will very often wrench the entire meter screw from its socket. The question of atmospheric contact with the interior of a meter is a matter to be taken into consideration in connection with the policy of removals; for when a meter is once placed in service, the gas in passing through will produce certain changed conditions on the interior of the apparatus—notably upon the diaphragms and valves, and also on other working parts. But the general effect of this gas action will vary greatly, depending on the style, the quality, or the grade of gas manufactured. The gas having once had its effect on these interior parts, produces, as stated, certain changes, which of themselves, in a great majority of cases, do not radically affect the operation, efficiency, or accuracy of the meter. A different condition, however, immediately

presents itself when the meter is disconnected from service, and the atmosphere is allowed to come in contact with the interior parts, as the changes produced, owing to the effect of atmospheric action, will almost immediately make themselves felt.

At one time, the greater part of the gas manufactured in the United States was coal gas, and meters in service in conjunction with this gas worked under conditions far more advantageous than with those operating to-day, when used in conjunction with the dryer type of gas now more generally manufactured. The old coal gas contained bye-products which, of themselves, greatly assisted in the preservation of the meter diaphragms, and at the same time, as a general rule, materially assisted in lubricating the valves. The dryer gases as now manufactured, however, do not offer this assistance to the operation or preservation of the meter; nevertheless they cause very little, if any, trouble on the meter valves.

The gas action just referred to, while not general, is of sufficient importance to necessitate careful investigation; and numerous experiments are now being made, not only by manufacturers, but by some of the larger gas interests, with the view of correcting this trouble as experienced in the drying-out of diaphragms. Different oils are being tried; and one notable experiment is being conducted on quite a large scale in the so-called process of "dipping" meters. This process may be briefly described as the method under which a certain amount of surplus oil is introduced in the bottom of each diaphragm compartment of the meter prior to setting it in service. The quantity of oil introduced in each compartment is sufficient to allow the lower edge of the diaphragm to remain immersed in the oil; the theory being that the diaphragm will automatically oil itself by capillary attraction.

It might be well to give some little additional attention to the question of the removal of consumers' meters from service. The gas manager or the superintendent should see that very great care is taken in the handling of the meter from the time it is removed until the actual tests of it have been completed. The average street employee, and very often the superintendent of distribution, will not realize the importance of keeping the meter so that the final removal test can be made as nearly as possible under conditions existing at the time the meter was in service; and on a job of this nature, when the workman disconnects the meter, he should, immediately upon breaking the connections, see that the meter is instantly closed at the tube screws—using either corks or tin meter-caps for the purpose. The meter should be carefully handled, and kept as nearly as possible in an upright position during its return to the meter-shop. On arriving, it should be placed in the testing-room, and left for at least 24, or, if possible, 48 hours, without removing the seals from the screws; the purpose being to allow the meter to attain as far as possible an even temperature with that of the testing-room. The meter should be tested with gas, as it has been operating under gas, and the tube-screws have been closed purposely to prevent the atmosphere coming in contact either with the valves, diaphragms, or other working parts, prior to the making of the test. If a removal meter is handled in this manner, and the test made as described, the result obtained will be an exact record of the actual proof of the meter as it was operating while in service.

There is a further matter which properly belongs to the question of maintenance, and that is in respect to the handling of removal meters in the matter of repair and replacement for the purpose of preparing them for further service or additional length of life. When meters are first brought to the shop, they should at once be placed in the testing-room for the purpose of undergoing a proof test, providing the gas manager would desire to keep all proof records on removal meters. After completing this preliminary proof or record test, the meter should be at once placed on test (to ensure it against inside leakage in the meter) as follows: The top should be removed, and the meter connected to the gas supply with a pilot-burner placed on the outlet of the meter; then the tester should light the pilot-burner, turn it down to an exceedingly small flame, and under this consumption make sure that the meter will make a complete revolution of the tangent within a reasonable time. A 5-light meter, with the flame turned sufficiently low to show only a blue flame, should make a complete revolution in about three hours. If it does not do so within a reasonable period, there will be gas bye-passing through inside leakage, or possibly sufficient lost motion from wear to prevent the meter operating correctly. It might be suggested, however, that the pilot-burner test with the blue flame is quite a severe one; and it would possibly serve the purpose of an ordinary gas company to use a somewhat higher or larger flame in making this so-called burner or pilot test. If on carrying out the burner test the meter should not make a complete revolution, it is very probable that the condition of the diaphragms is bad, that the valves probably need regrinding, or some other defective condition exists in the interior of the meter; and in the case of a small company not maintaining a complete repair department, it would be better, with a meter of this class, to discontinue any further work, and set the meter aside to be forwarded to a regularly equipped repairing-shop. If the meter should pass the pilot-test correctly, it would indicate a fair condition in the interior, and it can then be immediately re-tested for correct adjustment, topped up, and be ready for a new service connection.

A great many of the larger companies maintain their own repairing-shop, and with companies of this class meters should be handled in a general way similar to that just described for the smaller companies. A fully equipped shop, however, affords the larger company an opportunity to take care of all grades of meter-repairing work, including, when necessary, the complete stripping of meters, &c. With some of the larger companies, it is desirable to have a record of proof tests on all meters removed from service. Other companies, however, do not wish to keep this record. Should the record not be desired, the quickest procedure would be to take the meters, on their arrival at the shop, immediately remove the tops, and place the meters on the burner or pilot test; but with some companies even this test is omitted, and the meters are immediately opened—that is, the tops, back plates, backs, and fronts are removed. After removing these parts, the diaphragms are carefully inspected as to condition, and tested as to leakage. If the diaphragms should pass this inspection, the meters are set on the oiling-table and the diaphragms re-oiled from the outside without being removed from the case—being allowed to remain at least 24 hours in the oil-bath, and then receiving a second oiling, after which they are again allowed to stand at least overnight. The following day the interior of the diaphragm compartments can be cleaned of surplus oil, and the diaphragms tested. If they show tight on a pressure test of from 3 to 6 inches of water, the case should again be carefully cleaned out preparatory to putting on the backs and fronts; thus closing-in this portion of the meter. When this work is completed, it is necessary to clean out the top of the meter above the table (carefully cleaning the valves and all the fittings), after which the covers are placed in position, and the valves tried for tightness. If they show leakage, they should be reground, both the seats and the covers, after which the meter is ready to have the back plate put on, and for the pressure, pilot test, and proof tests. This operation would cover the so-called general repair of meters.

COAL TAR FOR BINDING BRIQUETTES.

There has lately been issued a "Bulletin" of the United States Geological Survey dealing with the subject of "Binders for Coal Briquettes." It has been prepared by Mr. J. E. Mills as the result of experiments made at the fuel-testing laboratory at St. Louis, under the direction of Dr. Joseph Hyde Pratt; and it is of interest, as showing a use for coal tar which is sufficient of itself to constitute a market for this residual. The following extracts from the report will give an indication of its nature.

The output of a briquette plant depends to a great extent on the size of the blocks manufactured. The cost of labour depends greatly on the size and arrangement of the plant and on the wages paid, which will vary considerably in different localities. The price of slack coal and of the different binders is even more dependent on the locality. An approximate idea of the total cost of manufacture, exclusive of the cost of the slack coal and the binder used, is here presented, in order to consider intelligently estimates which may be made of the maximum allowable cost of the binder—it being obviously useless to investigate a binder that could never be commercially used on account of its cost. M. Coze estimates the cost for manufacture in France at 33 c. to 40 c. per ton. Herr Schorr states that the cost in France is 24 c. to 34 c. per ton; in Germany, 22 c. to 24 c.; and in England, 24 c. (1s.). Estimates of the cost in the eastern and western parts of the United States indicate 30 c. to 50 c. per ton as being approximately the cost of manufacture. It appears that when the difference in price between the slack coal and the first-class lump coal is $1, the binder must cost less than 50 c. to 70 c. per ton. A binding material costing as much as $1 per ton of briquettes produced could be used profitably in but few places in the United States. Even allowing for future possible greater variation in price between the coal and the slack, it is not necessary to pay any attention to any binding material costing above $1·25 per ton of briquettes produced.

It is needless to say that a desirable binder should make a good briquette, and should make it cheaply. It will not, perhaps, be too great a repetition to summarize here, in the approximate order of their importance, the desirable qualities of a binder. They are: (1) It must be sufficiently cheap to make the manufacture of briquettes profitable. (2) It must bind strongly, producing a briquette sufficiently hard, but not too brittle. (3) It must hold the briquette together satisfactorily in the fire. (4) It must produce a briquette sufficiently waterproof to stand the conditions of use. (5) It should not cause smoke or foul-smelling or corrosive gases, or foul flues. (6) It should not increase the percentage of ash or clinker. (7) It should increase, or certainly not diminish, the heat units obtainable from a given weight of fuel.

The materials used to bind the particles of coal together may be either organic or inorganic; and a very large number of substances have at various times been suggested and used for this purpose. Among them, are the following:—

Tars and Pitches from Coal.—Blast-furnace tar, producer and illuminating gas tar, bye-product coke-oven tar, coal-tar creosote, and various grades of pitches from various tars.

Petroleum Products.—Crude oil, residuum (asphalts, &c.), water-gas tar, water-gas tar pitch, wax tailings, acid sludge, asphalt tar, Pintsch gas tar, and Pittsburg flux.

In ascertaining the value or suitability of a given pitch or tar

for briquetting purposes, three determinations are necessary: (1) The pitch or tar is distilled, and all oils coming off below 270° C. are rejected as of no value. (2) The flowing-point of the portion to be used is determined. It should generally be not less than 70° C. (3) The pitch is extracted with carbon disulphide. The smaller the amount of residual carbon, the more satisfactory the pitch. It should be borne in mind that the higher the flowing-point of the pitch, the more satisfactory it will prove in the fire when used with coals that do not cake readily. If the pitch has too high a flowing-point to be workable with the briquette machine at hand, it could be softened by adding high-boiling coal-tar oil (above 270° C.) or very soft pitch.

Two samples of producer-gas tar were examined. The first (designated 24C), after pouring off the water, gave on distillation: Water, 30 per cent.; oils below 270° C., none; oils at 270° to 330° C., 6 per cent. From 330° C. the thermometer jumped suddenly to 370°; and the distillation was stopped. The residue gave with Illinois coal a satisfactory briquette when only 4 per cent. was used as a binder. The next sample was tested after boiling off the water. The result showed a satisfactory briquette with Arkansas coal when 4 per cent. was used. But a larger percentage is necessary with most other coals; and probably 8 per cent. would be required for most lignites. The tar obtained, when freed from water only, is rather too liquid to produce the best quality of briquette. But the removal of only about 6 per cent. of oils raises the flowing-point of the tar to about 70° C.; and the residue appears to be excellently fitted for briquetting purposes. The amount of carbon disulphide extract obtainable from the residue was not determined. It should not be large, for the temperature at which the tar is made is comparatively low. This is probably the cause of the superior binding power of the pitch.

About 25 per cent. of the illuminating gas produced in the United States is made from coal, and the tar resulting from the process amounts to some 5 per cent. of the coal coked. The census report for 1900 gives the production for 1899 as 67,094 tons. In 1903, 61·4 per cent. of the coal tar made was produced in gas-works. This tar is too liquid to make good briquettes. The oils coming off below 270° C. should be disposed of. The residue, equalling 70 per cent. of the total, would cost $10·40 per ton, if the sale of the low-boiling oils could be made to pay the expense of the distillation and the profit thereon.

In 1903, 38·6 per cent. of the total coal tar (24,296,536 gallons) was produced in bye-product coke-ovens. The census report for 1900 shows that in 1899 only 3·33 per cent. of the total coal coked was coked in these ovens. Consequently, the amount of coal tar from this source could be enormously increased. This tar is obtained by distillation at a high temperature, and therefore contains more fixed carbon than tar from illuminating-gas plants. About 60 per cent. of the tar from an Otto-Hoffmann oven is really pitch. The tar is too liquid to be used directly for briquetting.

The principles governing the use of binders make it appear useless to test coal-tar creosote alone. It is too thin a liquid to make coherent briquettes, and of too low a boiling-point to give satisfactory results in the fire. This creosote could be used to thin a pitch of which the boiling-point is too high, when such use is advantageous. It could also be employed to waterproof a binder that would not stand the weather. But this could be done as well with a crude oil of low specific gravity, and the cost would be less.

One sample of pitch obtained by Dr. Pratt flowed at 100° C.; and the behaviour of the briquettes in the fire was satisfactory. Another sample was obtained through Dr. Pratt, and it had a flowing-point of 127° C. It was used in making a very large number of tests on the comparative action of different coals with the same binder. Another pitch was used to briquette 200 tons of Arkansas semi-anthracite slack; about 6·5 per cent. being used. This pitch had a flowing-point of 120° C., and was sufficiently brittle for use on the hottest day. It gave a carbon disulphide extract of 67·75 per cent. A sample of pitch was received through Dr. Pratt which had a flowing-point of 190° C.; being very hard and brittle. The carbon disulphide extract was 63·2 per cent. A large number of tests were made with this pitch when determining the qualities of binders in general, in order to learn why this grade was so poor a binder. This seemed to be due to two causes—(1) the large amount of contained free carbon (36·8 per cent.), and (2) the high softening point. At 100° C., the binder did not melt sufficiently to spread over the grains of coal to the best advantage.

To test this latter point, the pitch was mixed with a sample of wood creosote which did not itself possess sufficient binding power. A quantity (200 grammes) of pitch was mixed with 100 grammes of the wood creosote and heated with stirring until thoroughly mixed. The resultant pitch, which was brittle enough to be pulverized if kept cool, was then tried with a number of coals and compared with the original pitch. The results from this mixture show that in all the tests 4 per cent. more of the original pitch than of the mixture was required; thus confirming the diagnosis of the trouble.

None of the coal-tar pitches gave coherent briquettes with less than 6 per cent., and with many of them 7 or 8 per cent. was required. The reason for a coal-tar pitch not briquetting if less than 6 per cent. is used is that it contains a comparatively large amount of carbon. The residue from producer-gas tar made satisfactory briquettes with 4 per cent.—a result which was doubtless due to the fact that such tar contains little free carbon. The cost of coal-tar pitch per ton may be taken as $11; therefore the cost of the binder per ton of briquettes produced ranges from 66 c. to 88 c. The briquettes, when properly made, will stand exposure to the weather well. They will stand up satisfactorily in the fire if the coals cake at all readily. With non-caking coals, the briquettes would not prove satisfactory in the fire. This binder does not cause an undue amount of smoke.

The census report states that 75 per cent. of the illuminating gas produced in the United States in 1899 was water gas. Petroleum oil is used in enriching this gas, and is partly decomposed in the process; resulting in the formation of water-gas tar, of which 48,714,324 gallons were produced in 1899. With an average density of 1·1, this would be equivalent to 222,868 tons of tar. The tar itself is too liquid for use; but a pitch made from it was examined, as shown in the next paragraph.

The sample of water-gas tar pitch furnished to Dr. Pratt flowed at 92° C.; and with some of the coals 5 per cent. proved sufficient to produce excellent briquettes. The carbon disulphide extract was 88·10 per cent. With caking coals the briquettes are satisfactory in the fire. This pitch is worth somewhat less than coal-tar pitch; its value being given approximately $10 per ton. The cost of the binder per ton of briquettes produced would therefore be about 50 c.; effecting a saving of at least 20 c. per ton over the use of ordinary coal-tar pitch.

All the briquettes made with inorganic binders were brittle, though very hard. Experiment had shown that when brittle pitches, &c., were used, the briquettes became less brittle if a thinner pitch or oil was added. Therefore an attempt was made to improve these briquettes by the addition of organic binders. For this purpose coal-tar creosote, asphalt tar, and water-gas tar pitch were chosen. The briquettes made with Illinois coal and water-gas tar pitch were fairly good, and stood up very satisfactorily in the fire. The advantage gained, however, over the use of the water-gas tar pitch alone would not be sufficient to offset the introduction of the 6 per cent. of ash with the cement or the plaster of Paris, or the cost of the magnesium oxide when that material is used. The cohesive force of the briquettes made with the two binders was no greater than the sum of the cohesive force obtained with each separately. The only advantage to be gained by using such mixed binders would be an added strength in the fire. Experiments with California lignite were therefore made. The briquettes were found to be considerably improved as to their behaviour in the fire by the addition of the inorganic constituent of the binder. Briquettes from this coal made with pitch alone fall to pieces badly in the fire. The improvement in this regard, however, is offset by the added expense and the introduction of ash; and it is therefore considered more desirable, where possible, to mix such non-caking coals with caking coals before briquetting. If this is not practicable, then the addition of inorganic binders might be tried as a last resort. Should the inorganic binders be used, magnesium oxide and plaster of Paris will be found to give the most satisfactory results; 3 per cent. of the former being equivalent to 5 to 6 per cent. of the latter.

The "Eureka" Again to the Front.

We reproduce herewith an interesting photograph, which comes from the Essex Works of Messrs. John Wright and Co., Birmingham. The picture is taken from the works siding of the firm, and shows their special train of 24 trucks, loaded with "Eureka" cookers, which we understand formed one single order. We are

not told whether this sort of thing is a daily occurrence at the Essex Works; but at all events we imagine that not only Messrs. Wright and Co., but most manufacturers, would be glad to find the monotony of their matutinal post-bag often relieved by an order of equal proportions.

The use of concrete and reinforced concrete pipe for culverts in railway embankments has suggested to Professor A. N. Talbot an elaborate series of experiments, described in Bulletin No. 22 of the University of Illinois. According to "Nature," the results throw light on the resistance of pipes to embankment pressures, and also upon the action of sewers under similar conditions. Cast-iron pipes, concrete pipes, and reinforced concrete pipes were tested. The specially prepared testing apparatus used included a box of strong and stiff construction, the pipes were embedded in sand, and the load applied through a saddle which rested on a sand cushion. Auxiliary tests were made to connect the results of the investigation with the inherent strength of the materials.

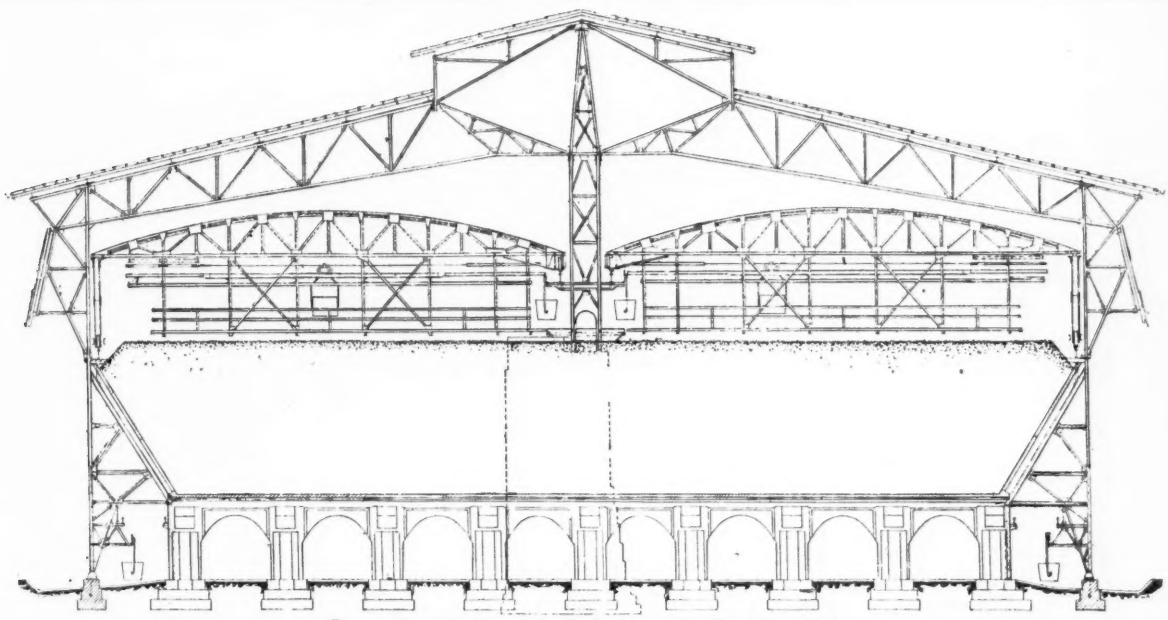


Fig. 1.—Cross Section of the Coal-Store at the Tegel Gas-Works.

COAL-STORES.

By Herr E. MEIER, of Schöneberg, Berlin.

[Abstract Translation of a Paper read before the German Association of Gas and Water Engineers, June 16.]

The most spacious building in the extensive new gas-works (at Tegel) of the Berlin Corporation, is the coal-store. This building is 1883 feet long, 168 feet wide, and has a height of 92 feet to the ridge of the lantern roof. The coal is stored to a height of 26 ft. 3 in., and the total quantity which the building will contain is 170,000 metric tons. Fig. 1 is a cross section of the store.

The coal-store consists of: (1) A substructure comprising an *entresol* or middle floor, with containing and partition walls, and (2) a superstructure, which consists of the roof-framing, and the attached girders, which carry the rails of the suspension railway bridges. This upper part was erected by the gas undertaking. Fig. 2 gives a view of the substructure. The erection of it was put up to open competition, and the author's design was accepted as being the most suitable and the cheapest. Fig. 3 shows the construction of the substructure—*i.e.*, the foundations on which are erected the columns to which the binding arches, having a span of 11·8 feet, are attached. Arches spring right and left from these with the same span of 11·8 feet. The horizontal thrust of the arches is taken up by iron rod ties, $1\frac{5}{8}$ inches diameter, placed at intervals of nearly 3 feet. If the coal is uniformly distributed on both sides of a column, then the latter is loaded only in a vertical direction. Its maximum vertical load—viz., that of coal uniformly distributed to a depth of 26 ft. 3 in.—would require the column to have a cross section of about 9·7 square feet. But if the coal is stored on one side of a column only, then, in addition to the vertical load, which in that case is less than before, there is also the strain due to the horizontal thrust of the binding arch, tending to overturn the column. If the columns were of square section, notwithstanding the reduced vertical load, the 9·7 square feet cross section named would not have been adequate. The overturning pressure of the horizontal thrust on the other side would have been too great. This pressure becomes smaller the greater the base of the column. For this very reason, while the cross sectional area of 9·7 square feet was maintained, and the same quantity of material employed, the columns were expanded until the maximum strain from one side was not greater than the maximum vertical load with a depth of 26 ft. 3 in. of coal. The columns thus assumed the form shown, which at the same time afforded the advantage that the discharging openings could be constructed in the columns, or between the abutments of the arches, without weakening the structure more than in the slightest degree. This is the principle of the author's design, which statically and practically affords a highly advantageous solution of the coal-storage question.

The discharging openings have thus, as compared with the only alternative of placing them in the arches, the important advantage that the natural surface for a shoot is obtained in the simplest and cheapest manner with the most suitable inclination. The same applies to the discharging grids, as they are not thus exposed to the vertical pressure of coal heaped to a depth of 26 ft. 3 in., but are only loaded under the pressure due to the angle of inclination. Altogether in the store there are 1107 of these discharging openings. The cost of mechanical closing valves

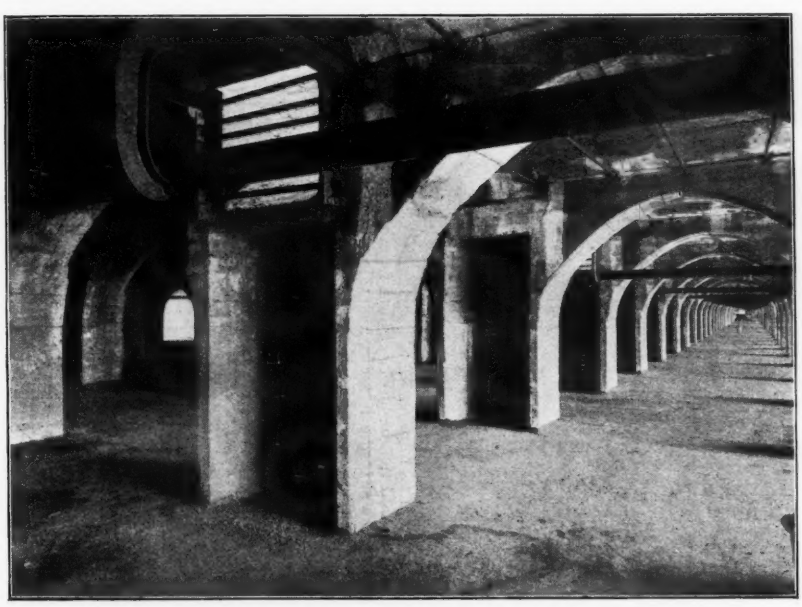


Fig. 2.—View of the Substructure of the Tegel Coal-Store.

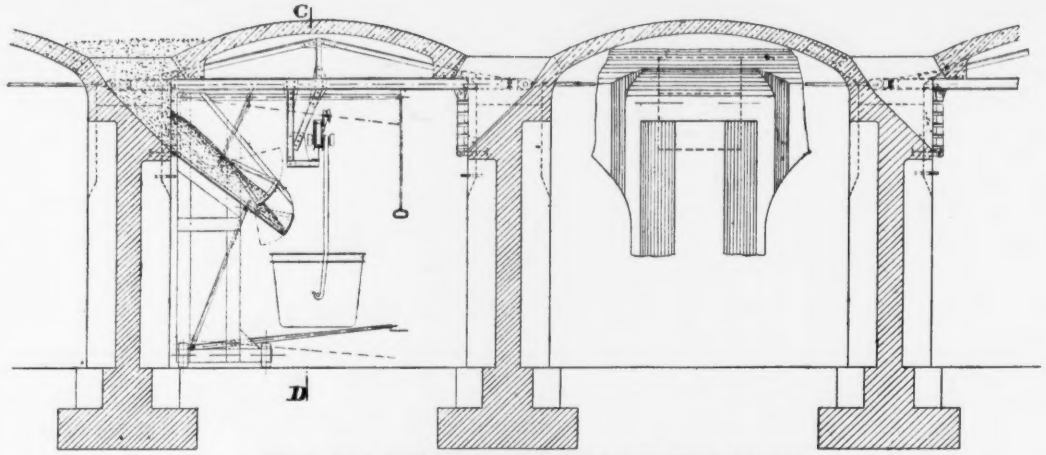


Fig. 3.—Cross Section of the Substructure of the Tegel Coal-Store.

for the openings would have been about £15 each; and while the provision of them for all the openings would have facilitated the rapid removal of the coal, the total cost would have reached some £17,000. The gas-works authorities therefore provided only a very limited number of the appliances, but made them portable; so that they could be shifted from opening to opening, and attached to the latter in a simple manner. The grid bars are then removed, and can be replaced if the coal above the opening has only had to be partially drawn off. This may happen when, for instance, a change is suddenly called for in the description of coal to be carbonized.

The bars are introduced from above, so that the coal is gradually drawn off from before them. The portable closing valves are then moved on and connected to other openings. As a rule, however, the coal from one opening will all be drawn off at once, and the portable valve will not be moved on and the grid bars replaced until then. The arrangement described has effected a saving in expenditure of some £16,000. The openings are placed at intervals apart in the longitudinal direction of the store of 15 feet, and transversely of 17 feet, measured from centre to centre in both cases. The disposition of the openings above the columns allows the coal to be drawn off at any time from two adjacent openings in one row of arches, so that the next row need not therefore be provided with a suspension railway.

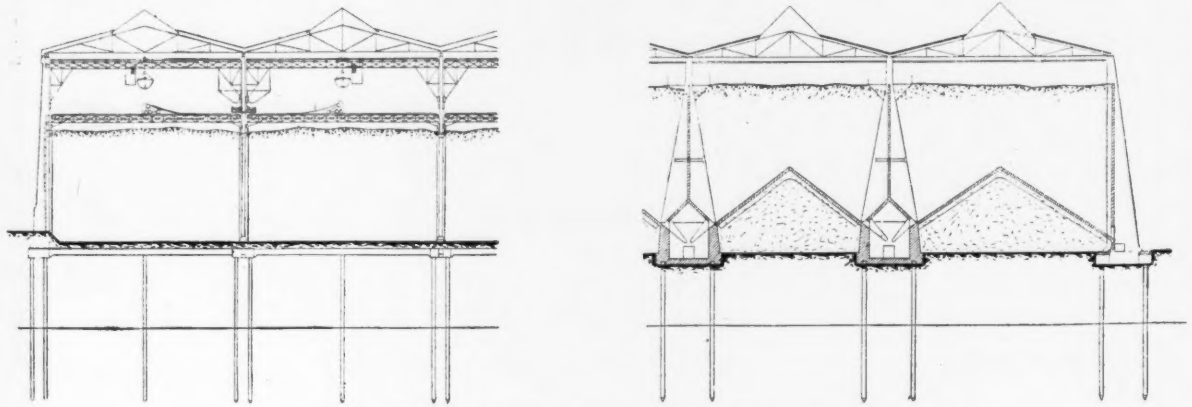
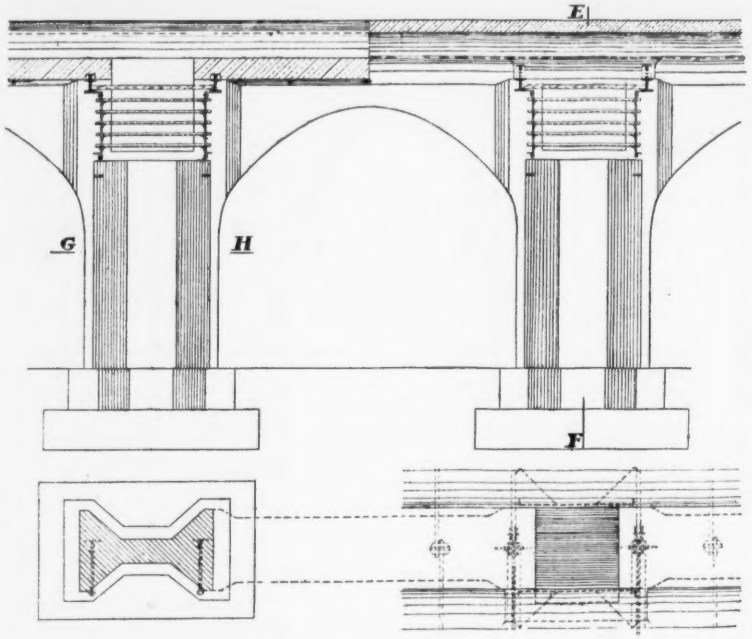


Fig. 6.—Cross Section of the Grasbrook Gas-Works (Hamburg) Coal-Store.



There has thus been saved about 3300 yards in all of suspension railway, in about 60 rows, with the necessary supporting framing. The saving in expenditure on this account has been about £5500.

The side walls are so constructed that they are inclined at an angle of about 27° to the vertical. The coal, when put in, rests in layers on the slope; so that the moisture is afforded a good opportunity of evaporating from it. The risk of fire is thereby greatly diminished. The fall of the coal from a great height, resulting in much crumbling of it, is also avoided. This design entails only a very slightly greater expenditure than vertical side walls. The walls have a rather greater surface, and must be somewhat more substantial. But the capacity of the store relatively to the area of ground occupied by the building is greater—which equalizes the cost. Fig. 4 shows a cross section of a store with vertical walls. Comparing it with fig. 1 shows the advantage gained by the Tegel design with sloping walls. The available capacity of the Tegel store is greater than that of the other for the like area built upon, because the Tegel store makes available for store purposes half the base of the area over which the side walls extend. As the base of the side walls is greater in the Tegel design, the iron construction is rather lighter. The store is so constructed that no part of the iron structure stands in the coal and is liable to heating therefrom. If the coal should become thoroughly on fire, it could, in the worst case, be allowed to burn out as though it were in a large tank. The coal-store is like a system of immense tubs. At intervals of about 165 feet along the central axis of the store there are masonry columns on which are erected the pillars on which the roof framing is carried, and the railway bearers for the travelling suspension line bridge. Inside the masonry columns are massive winding staircases, which are reached from the lower corridors of the vaults, and give access to the longitudinal axis of the store above the highest level of the coal therein.

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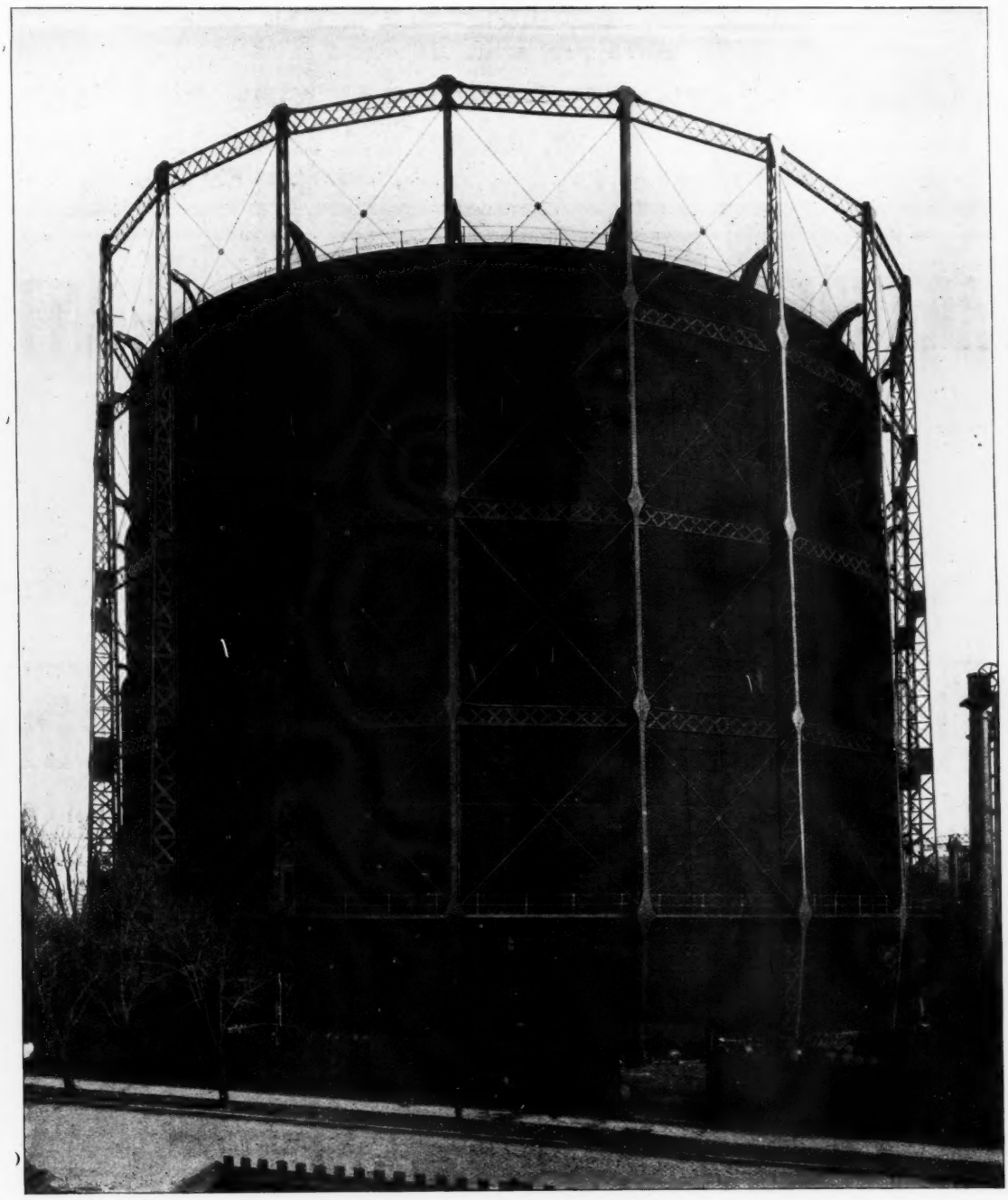

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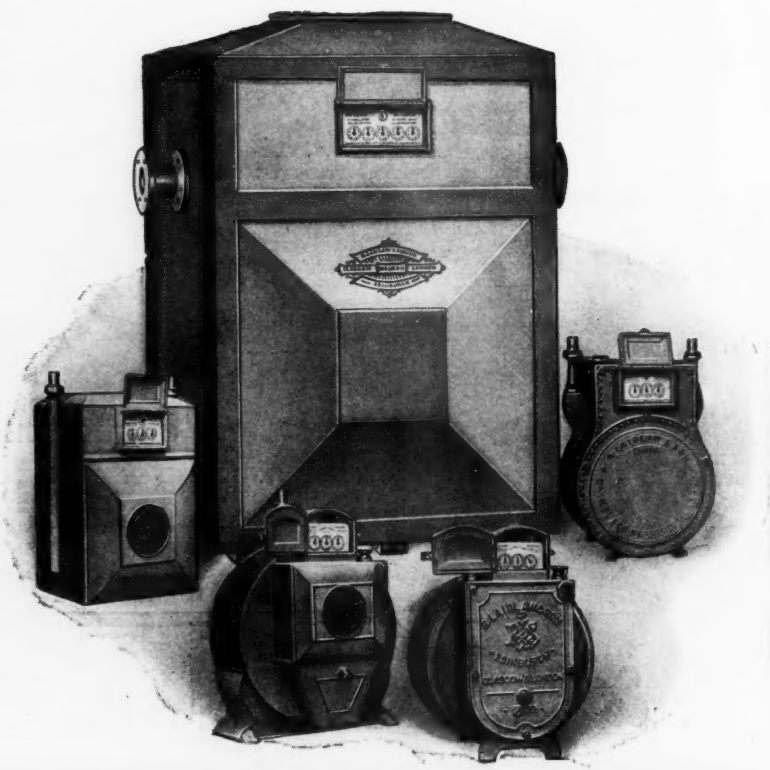

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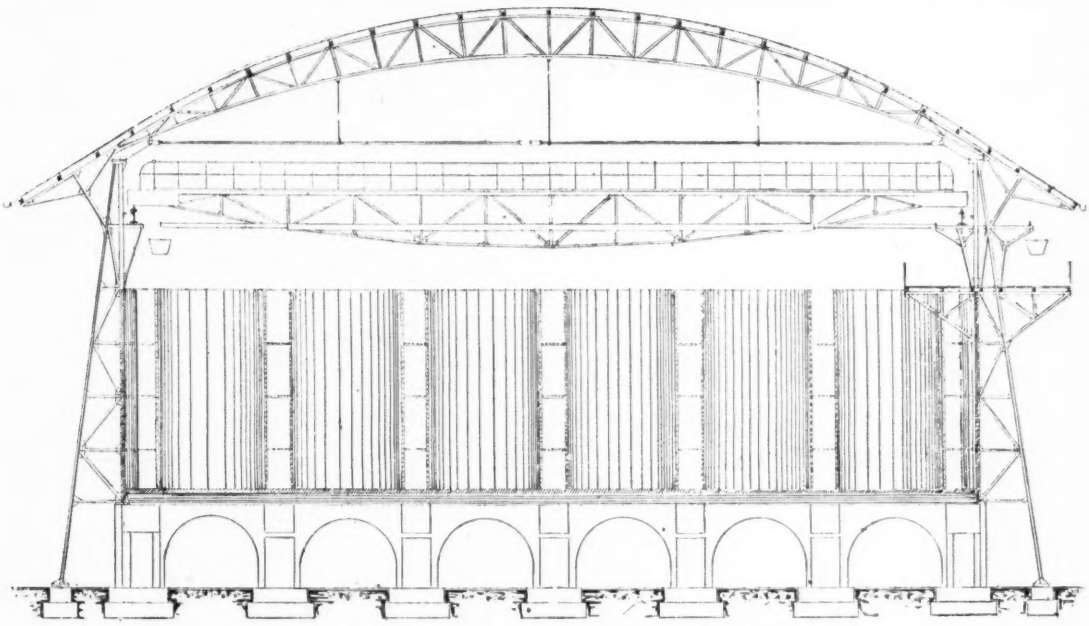


Fig. 4.—Cross Section of a Coal Store with Vertical Walls.

The construction of the substructure thus becomes of more extended importance. It entails a minimum of outlay, and so greatly facilitates the provision of coal storing installations for large works.

There are many mistaken impressions as to the cost of this type of substructure. The Berlin gas undertaking has been led to prefer the plan of withdrawing the coal from the bottom of the store for these reasons: The method reduces the cost of handling the coal to a minimum. In case of the firing of the coal, it is extremely difficult to reach it from above by means of grabs. Hence at Tegel the coal is withdrawn from the bottom of the store, whereas the coke is removed from store from above. Moreover, the cost of the installation is about the same whether the coal is taken up by means of grabs, or taken off from below as at Tegel. The objection that the store is increased in height by about 13 feet owing to the substructure is seen to be untenable by comparison of the view given in fig. 5 with fig. 1. The latter is a cross section of the Tegel coal store, and fig. 5 that of the Cologne store, from which the coal is removed from the top by means of grabs. The 13 feet required by the substructure is here taken up by the bridges on which the grab-cranes travel, and by the railway on which the bridges are moved. The conveyor bridges and their carrying railway, with the supporting columns of the latter, are, moreover, very heavy, and must have substantial foundations, as the grabs, which work only in virtue of their own great weight, require to be at least two or three times as heavy as the load of coal they raise.

The whole construction is rendered more costly by the fact that the grabs must work at any spot in the store. It thus comes about that the whole cost of the open store is as high as the substructure store. This will be seen best from the table on p. 332, in which are compared the Tegel store with its substructure, consisting of the store-floor with side and gable walls, the lower suspension line with all the appurtenances, valves, &c., and an open store, with the iron framing for the travelling railway on both sides and the necessary foundations, crane bridges and grabs, and electrical equipment. The roof and the suspension railway by which the store is filled, are cut out in both cases. It will be seen that the cost per unit area of ground covered is approximately the same. The cost per ton of coal stored, however, comes out considerably in favour of the Tegel type of store, as with it the coal is piled to a depth of 26 ft. 3 in., as compared with 16 ft. 6 in. for the open store. A greater depth is not permissible with the latter type of store because of the risk from the coal firing; and thus the Tegel pattern becomes the cheaper.

Most technical men are agreed that dry coal is more economical; and on this account the roofed store only has to be considered. This being granted, the foregoing table affords sufficient evidence that the store from which the coal is withdrawn at the bottom is absolutely the cheapest. But the author is far from contending that the Tegel design, though it was really the least costly in that instance, should be adopted in all cases. At Tegel a good foundation was secured at a small depth; and, consequently, the numerous columns did not entail excessive expenditure. But it is different, for instance, at Hamburg, where it is necessary to go to a depth of 46 feet to obtain a good foundation. The columns

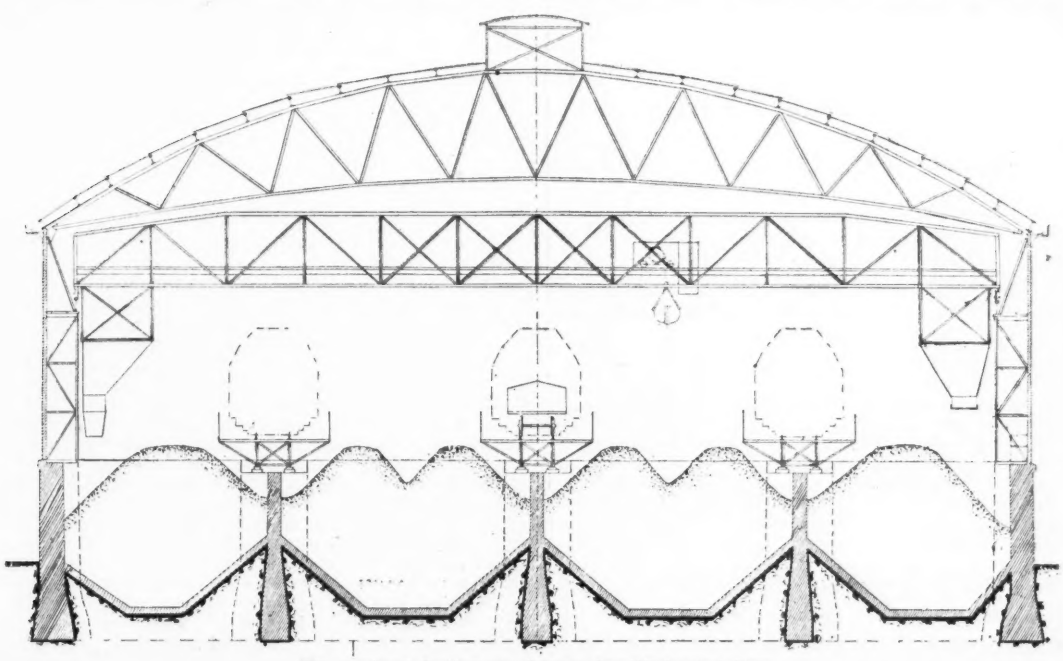


Fig. 5.—Cross Section, the Cologne Gas-Works Coal-Store.

Tegel Coal-Store.

[Length, 1883 feet; width, 168 feet; area covered, 316,463 square feet; storage capacity, 170,000 tons.]

—	Total Cost.	Cost per Square Foot of Ground Covered.	Cost per Ton of Coal Stored.
Roof	£17,515	13·4d.	2s. 9d.
Walls	11,850	9·0	1 5
Lower suspension railway, without waggons	8,280	6·3	0 11½
Total	£37,645	28·7d.	5s. 1½d.

Open Coal-Store.

[Length, 656 feet; width, 164 feet; area covered, 107,640 square feet; storage capacity, 36,000 tons.]

—	Total Cost.	Cost per Square Foot of Ground Covered.	Cost per Ton of Coal Stored.
Iron construction, 460 tons, at £15	£6,900	15·40d.	3s. 10d.
Foundations	875	1·96	0 6
Crane bridges with grabs (1·8 tons capacity)	4,720	10·50	2 7¼
Electrical equipment	625	1·39	0 4¼
Total	£13,120	29·25d.	7s. 3½d.

would then involve an enormous outlay on special piles for their support. In such cases the author would adopt the construction shown on the right in fig. 6. The principle of taking away the coal from the bottom is retained. The cross section to the left of the figure shows the design on which tenders were invited, which involves removing the coal from the top. The cross section to the right is the author's own design. The store is 34 ft. 6 in. high. All the coal at Hamburg is stored under cover. The capacity is about 65,000 tons. Columns, partition walls, and the channel by which the coal is taken out have their foundations on rows of piles. The channel may be as large as wished, and is best placed underground to the depth of the highest level of the water in the soil. This is the salient point in the solution of this problem, as the foundations represent a considerable part of the cost of the whole installation.

It is impossible, generally speaking, to fix a standard of cost for coal-stores, as the design can be carried out in so many different ways. There were 40 tenders sent in in response to a call. The lowest was for £40,950 and the highest for £95,000. These enormous differences depend primarily on the method adopted for solving the problem, and therefore come back to the manner in which the constructing engineer attacks it.

The reading of Herr Meier's interesting paper was followed by a short discussion on the most advantageous methods of storing coal, in which, among others, Herr Pohmer, of Mariendorf (Berlin), Herr Prenger, of Cologne, Herr Weiss, of Zurich, and Mr. E. Körting, of Berlin, participated. The last-named regarded the storage of coal in the open as quite proper and free from disadvantage.

[We are asked to state that the design of the Tegel coal-store has been patented in England by Herr Meier.]

COAL AND COKE HANDLING PLANT AT THE AVON STREET GAS-WORKS, BRISTOL.

At the Meeting of the Institution of Mechanical Engineers at Bristol last week, Mr. WILLIAM STAGG, the Superintendent of the Avon Street station of the Bristol Gas Company, read a paper on "Inclined Retort Coal and Coke Handling Plant at Bristol." We gave in the "JOURNAL" for Jan. 6, 1903 (p. 29), an illustrated description of the inclined retort-house at the above-named station. The following extracts from Mr. Stagg's paper furnish additional particulars in regard to its equipment.

The author began by pointing out that as it is estimated that about 15 million tons of coal are carbonized annually in gas-works in this country, the economical handling of this large quantity of material and of its principal bye-product is of vital importance in gas undertakings; and he expressed the hope that it would afford a subject of interest to members of the Institution. In Bristol, which was among the first of the provincial cities to light its streets by gas, last year nearly half-a-million tons of coal and coke were handled. The oldest works are at Avon Street, where there may still be seen a very interesting series of ten retort-houses built nearly a hundred years ago. In plan they present the form of a horseshoe, with a covered coal-store occupying a central position and opening into each of the retort-houses—all admirably adapted to the requirements of those days. They are a standing monument to the foresight and the enterprise of the pioneers of the gas industry in Bristol. For the greater part of the century that has passed since the introduction of gas lighting, little was done to introduce strictly mechanical methods in the handling of materials. However, of late, various forms of machines for charging and discharging horizontal retorts, with their auxiliary plant for handling coal and coke, have gradually come into use. Having given a short description of the earlier charging and discharging machines, projectors, and ram dischargers, Mr. Stagg referred to the combined charging and discharging machine of Messrs. Fiddes and Aldridge, by which the two operations are carried on simultaneously—the ram removing the spent charge carrying in the fresh charge of coal by the same movement.

Passing on to deal with the gravity method of charging and discharging retorts, as embodied in the inclined system, the author explained that it is characterized by extreme simplicity. The retorts are inclined at an angle to the horizon, and the coal from continuous hoppers is dropped directly into the retorts through portable charging-shoots. The recent introduction of coal-projecting machines in conjunction with ram dischargers has to a large extent checked the progress, for the time being, of the inclined-retort system, because with apparatus of this class retorts can be charged and discharged by the employment of a machine at one side only of the retort-house—thus offering considerable advantage compared with the older forms of stoking machines, which work from both sides of the retort. Where the work is continuous, machines must be of the simplest, strongest, and most durable character to avoid the risk of a breakdown; and considering the conditions prevailing in which they are expected to work—the great heat and the cutting action of the coke upon the wearing parts—it may be wondered why any other method than the inclined system should be employed for charging retorts. However, greater care is necessary in the selection of suitable coal; and the success of the system depends, in a measure, upon the type of coals from day to day being fairly uniform. Some gas coals have a tendency to slip during the earlier stages of carbonization in inclined retorts, and in doing so a downward creeping movement readily sets in, leading to a thickening of the charge of coal at the lower end of the retort, thus rendering efficient carbonization difficult. Avoiding these slipping coals, Mr. Stagg said the system was as near perfection as could be attained by any method.

The author then proceeded to give the following particulars of an installation of inclined retorts at the Avon Street Gas-Works: On the "new side" of the works three very substantial retort-houses adjacent to the harbour were erected in 1860. In order to make the most of these buildings, it was decided in 1900 to raise the roofs and double the height of the walls, and by this means afford accommodation for inclined retorts. The dimensions of the houses and the general surroundings lend themselves admirably to this method of carbonization. The work was designed and carried out by, and under the personal superintendence of, the Company's Chief Engineer, Mr. Daniel Irving, and the work executed by the Gas Company's own staff and workmen. The coal can be lifted from the hold of the steamboat lying alongside the quay, weighed, broken, elevated, conveyed to any part of either three retort-houses, charged into the retorts, and when carbonized discharged from the retorts directly on to coke-conveyors, cooled, conveyed into the yard, screened, stored, and then loaded into carts or trucks without the material being once handled. The plant is divided into two sections—for coal handling and for coke. The power required is supplied by gas-engines provided in duplicate for each section. The coal breakers and elevators are also in duplicate, and the coal can be placed in any part of the coal-hoppers of the three retort-houses from either breaker. The coal-handling plant is designed to do its work, as far as possible, during the hours of daylight; 300 tons per day being required of it.

The determination of the angle of the retort, as might be expected, is a critical question. The ideal coal for working with is "nuts," such as will pass through a screen of 1¼-inch mesh. Compared with this lively type, small coal requires a steeper angle, especially if damp, and larger coal a less angle. An angle that would serve well in a newly-built bench would be less suitable as the retorts become worn, in consequence of the formation of irregularities on the inner surface and of ridges at the joints, which impede the descent of the coal; and generally a steeper angle might be employed for discharging than would be suitable for charging. For a slipping coal, a less angle would be more serviceable. Lastly, the amount of vertical drop of the coal from the measuring chamber to the charging mouthpiece of the retort varies for each horizontal line of retorts, and introduces another disturbing factor, which requires some compensation, and which is provided for by introducing baffles and checks in the charging-shoot. Obviously, then, a compromise in the angle is necessary to satisfy conflicting claims; and the angle decided upon is 31°.

The accompanying diagram (fig. 1) shows a cross-section of the retort-house. It will be noticed that the charging-floor is placed upon a higher level than the discharging-floor, allowing of this angle of 31° as the inclination of the retorts. High up over the retort mouthpieces on the charging side is a continuous coal-hopper A, supported partly from the bracing of the retort-bench and on cross-joists resting on the walls of the retort-house. Over each vertical line of four retorts a measuring chamber B, for the charge of coal, depends from the hoppers—20 in all. In each of these chambers there is a slide at the top for filling it from the

hopper, and another at the bottom for discharging, each worked from the charging-floor of the retort-house by a separate lever. The full capacity of the chamber is 7 cwt. This may be reduced by pushing in a flap-plate, which hangs hinged inside the chamber, held in position by a quadrant which passes through the back of the chamber, and is fixed by a pin. The weight of the charge of coal can by this means be adjusted to suit the prevailing conditions.

The method of charging the retorts is as follows: A portable stop-plate C is placed in the retort at its bottom end, in order to prevent the charge of coal from resting upon the relatively cold iron mouthpiece, and from pressing against the retort-lid. This remains in the retort during the period of carbonization. On the charging side are four shoots D, one for each horizontal line of retorts; the lower hinged end of one of these shoots is placed in a retort, and the contents of the measuring chamber are discharged into it by pulling a lever—the coal forming along the bottom of the retort an even layer about 6 inches thick from the stop-plate to the upper end of the retort. These charging shoots are provided with adjustable baffles, and in the longer shoots fixed baffles also, for regulating the speed of the descent of the charge of coal—thus aiding the operator, who has the chief control. The weight of the charge is from 6½ to 7 cwt.; and 20 retorts can be drawn and charged in 25 minutes. The retort-lids and the face against which they close are machined; the retort being sealed by pressure from a lever with an eccentric shank.

The retorts are tapered; increasing in width towards the bottom ends to facilitate the discharge of the coke. In this installation they are arranged in sets of eight—two vertical lines of four retorts under each of the ten arches, each set being independently

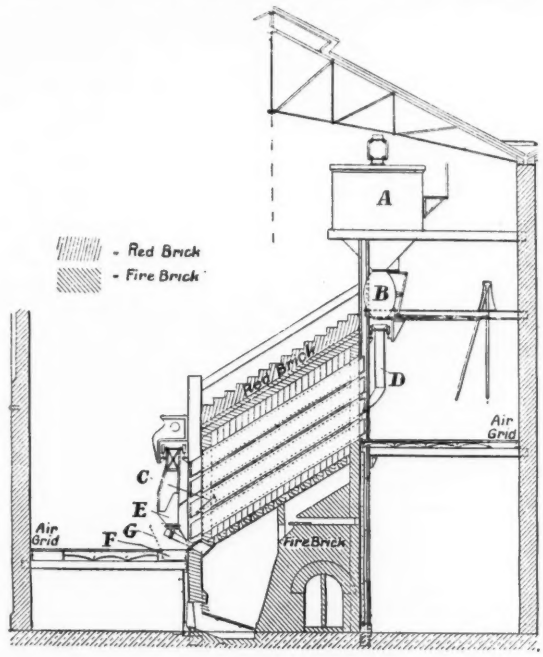


Fig. 1.—Cross Section of No. 3 Inclined-Retort House.

heated by producer gas on the regenerative system. A fraction of the hot coke as it is discharged from the top line of retorts is directed through a portable shoot hung on rails into the producer E; the only manual labour necessary being to push it back in order to maintain an even thickness in the depth of the fire. The clinkering is done from the ground-floor stage below. Owing to the regular heating possible in this system, the life of the retorts and of the setting is prolonged. A bench is still in action at the Avon Street works in which the heats have not been once let down since August, 1904—having done continuous work for nearly four years.

Water-borne coal is unloaded by means of a steam-crane and a Hone grab. The grab, of 15 cwt. capacity, discharges into a hopper weighing-machine, in which the weight of the coal is indicated by a pointer on a scale of hundredweights. This arrangement permits of rapid weighings, as the shifting of the counterpoise is unnecessary. From the weighing-machine it is discharged by a lever into the hopper of the breaker, together with coal received by carts, and there reduced to a uniform and suitable size. The breaker is a powerful machine capable of dealing with 30 tons of cannel per hour. The coal is fed in automatically by a shuffle-plate to two double lines of steel claws on square shafts suitably enclosed. The breaking is done in two stages. The coal falls from the second pair of claws into the boot of the elevator. During its 6½ years' continuous work, this has dealt with 360,000 tons of coal without having been once taken apart for repairs, notwithstanding the rough usage it has sustained from stray train-coupling links, axle bearings, and stones which occasionally find their way in with the coal. The steel elevators are constructed of a central roller-chain upon which buckets of 28 lbs. capacity are fixed, 18 inches apart. They are driven from the top end by a sprocket-wheel which engages the connecting-chain. Projecting arms, fixed on each side of the buckets, slide on angle-iron bars, which serve as guides. The coal is elevated to the full height of the lofty retort-house walls, a total lift of 70 feet, and there delivered into the conveyors for distribution.

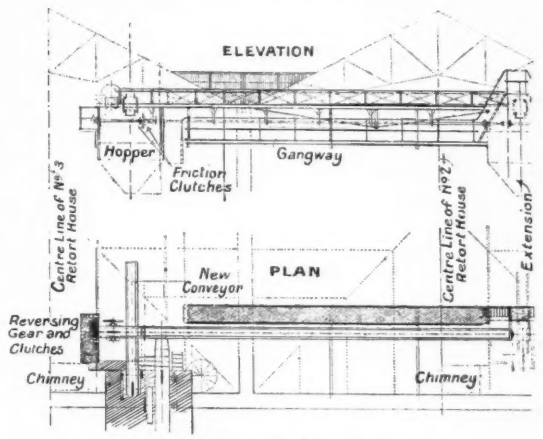


Fig. 2.—Cross Coal-Conveyor.

Each of the three retort-benches is served by its own conveyor, fixed on cross-joists above the continuous hopper; and a fourth conveyor, at right angles to these, stretches from one elevator head to the other. This cross-conveyor (fig. 2) is fitted with reversing gear and clutches, and so arranged that coal from either elevator can be delivered on to each of the hopper conveyors, and thus serve all three benches in turn. These conveyors are driven from the elevator head by chain-drives. The coal from the elevator is directed by a shoot into the trough of one of the conveyors; and along this the coal is swept by a continuous chain of push-plates to the first open slide, where it falls either into the cross-conveyor or into one compartment of the coal-hopper.

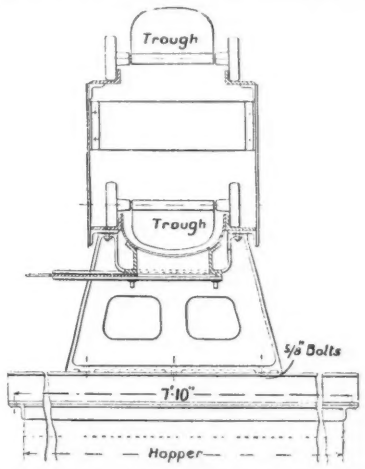


Fig. 3.—Section of Semi-Elliptical Coal-Conveyor.

It will be seen from fig. 3 that the section of the trough of one of the conveyors is semi-elliptical. In this conveyor every third push-plate is provided with wheels and an axle, and the whole is connected up by a chain of the roller type, driven by a sprocket-wheel at one end, which engages the rollers on the links of this chain. At the opposite end of the conveyor, screw tension-gear is provided, which acts through a second sprocket-wheel. The wheels carrying the push-plates run upon angle-irons fixed at each side of the trough. A more efficient conveyor could scarcely be devised. It needs very little attention; and, owing to the slippery character of the coal, it requires very little lubrication. During its six years' work, it has transported about 220,000 tons of coal. Such ample bearing surfaces have been provided that, excepting the bottom of the trough, where the coal falls upon it, the amount of wear has proved to be insignificant. In all the other conveyors, the section of the trough is rectangular, and every push-plate is provided with its wheels and axle. The coal moves along at the rate of 100 feet per minute. To drive the whole plant—consisting of two breakers, two elevators, two hopper-conveyors, and one cross-conveyor—when running light, requires 35·89 I.H.P., and 35 per cent. more, or nearly 50 I.H.P., when dealing with coal.

The following is a description of the coke-handling plant. Along the front of the retort-bench, below the bottom line of retorts and below the floor-level, is a rectangular trough F (fig. 1), constructed of steel plates and angles, with cast-iron renewable bottom wearing-plates. This trough is covered with ⅜-inch

plates with a hinged section G in front of each vertical line of retorts. The plates serve to confine the heat and steam to the trough as the coke is conveyed through the house; and when raised for discharging the retorts, they serve as shields to protect the workmen from the falling hot coke. Beyond the house, the conveyor trough is bent upwards at a considerable angle, becoming an elevator. This portion, being entirely enclosed, acts as a flue, and draws the steam from the retort-house—discharging it at the top end entirely clear of all workmen. Along the walls of the retort-house a line of wrought-iron gratings takes the place of the ordinary brick floor, and allows a plentiful circulation of cool air in the house.

The coke and breeze storage-hoppers rest upon pillars, and are raised sufficiently to allow carts to stand underneath the hoppers. They are divided into sections by bulkhead plates, corresponding with the screens; and below each pair of screens the hopper is partitioned off for breeze. Above and along the entire length of the hoppers, carried upon a lattice framing, there is a conveyor for distributing the coke. As the coke leaves the retort-house it is quenched, and on reaching the top of the elevator it is discharged into the trough of the distributing or hopper conveyor, and either falls directly on to screens through the open slide beneath, or is carried to the next set of screens, where it is separated from the breeze, and each falls into the section of hopper set apart for it. To save the coke from breakage in falling into the hoppers, portable shoots are placed when required at the foot of the screens. The carts are filled by operating a lever from the ground-level.

The form of conveyor chain adopted for the coke plant is the De Brouwer, which resembles a flexible ladder with cross-bars of round and flat steel. Where the coke has to be taken up inclines, flat bars are introduced at regular intervals in place of the round bars. The conveyor, when new, moves along at the rate of 50 feet per minute. This speed is increased as the wear of the chain necessitates an increase in the diameter of the pitch circle driving sprockets.

In discharging the retort, the coke slides down the inclined retort into the trough in front of the bench, and is carried forward, sliding along the bottom plates. A little water lies in the bottom of the trough to keep things cool, and this helps to quench the coke as it travels along. In spite of the trying conditions under which it has to work, and of the cutting and grinding action of coke, a chain may be made to last more than three years, working day and night, and transport 70,000 tons of coke during its life. The new chain weighs 50 lbs. per yard; an old one removed to the scrap heap weighs 32 lbs. per yard—showing a loss in wear of 36 per cent. by weight.

The chain of the conveyor is driven by a pair of sprocket-wheels, engaged for 90° of the pitch circle. The slack chain is paid directly on to guide-wheels, which maintain it in constant tension by a balance-weight. The chain of the hopper distributing-conveyor is kept taut by tension-screws instead of the usual balance-weight arrangement, which cannot be well applied where the conveyor has to be reversed. In this case the chain is apt to increase in length more on one side than the other. Sections of the chain have frequently to be turned over, to counteract this unequal wear and consequent difference in the pitch of the two sides. Judging from what takes place at the Avon Street works, one would be inclined to think that the introduction of a balance-weight in place of the tension-screw would overcome the difficulty; but the experience at other works renders this doubtful.

The amount of power required for these conveyors is surprisingly small, and is supplied by a gas-engine. A length of 1540 feet of conveyor-chain requires, when light, only 25·16 I.H.P., including two line-shafts, belts, and driving-gear, and 12 per cent. more when fully loaded. So thoroughly reliable are gas-engines, that for nearly three years work was proceeding day and night, year in and year out, with a single gas-engine. The rapidity and ease with which hot coke is removed from the retort-house by conveyors adds much to the convenience and comfort of the workmen, and to the general economy of the system.

Discussion.

The PRESIDENT (Mr. T. Hurry Riches) proposed a vote of thanks to Mr. Stagg for his paper.

The motion having been carried by acclamation,

Mr. W. H. ATHERTON (Derby), referring to the statement in the paper that the introduction of coal-projecting machines and ram dischargers had checked the progress of the system of inclined retorts owing to the fact that they allowed of retorts being charged and discharged by machinery working on but one side of the bench, pointed out that this was not the only reason. Most gas-works, he said, already had hand-charged horizontal retorts, and the use of projectors enabled the old settings to be utilized, and labour-saving methods adopted with a small outlay of capital and no interruption of working. He, however, looked forward to seeing both horizontal and inclined retorts displaced by verticals in the course of the next decade. The latter was the ideal system in principle, as embodied in the Woodall-Duckham retorts. He asked the author if he could give the members some idea of the difference in capital cost of two new retort-houses of equal capacity, one equipped with inclined retorts and the other with horizontals, both with modern appliances. Proceeding to criticize the details of the coal-handling plant described in the paper, Mr. Atherton said in his opinion the receiving-hopper below ground was unusually shallow—the inclination of the sides being only about 35°; and he asked the author if he had found that this was sufficient to allow the coal to flow freely. He thought the jigger-feed was better than the use of sliding doors alone, as with the latter the coal often became jammed, and had to be stirred up by hand. The drive for the elevator head was unusual; and he considered a chain-drive would be preferable, being more flexible, and requiring fewer bearings. The three types of conveyor now used in retort-houses—the push-plate, the band, and the bucket—were all good; but the first-named (the one shown in the paper) was probably the most convenient and durable where coal had to be deposited at a large number of points. The two forms of cross-section given in the paper had unusually deep push-plates, necessitating room overhead, and throwing great strain on the chains. He produced on the blackboard a sketch of a modified design of conveyor.

Mr. CANNING (Newport) said the Directors of the Newport Gas Company decided some years ago to introduce coke-handling plant, and they had used gas-engines to drive it. These were very good, and thoroughly reliable; but electric motors had now been installed, because the work was spread over so large an area.* Coal was tipped from waggons into the hoppers, thence discharged into the breakers, and the rest of the operations were carried out on the lines described by Mr. Stagg, except that horizontal retorts were being used. As they had a separate electric motor for the breaker, the power could be measured with great exactness by recording instruments. Usually the power was from 8 to 12 E.H.P., though frequently it amounted to 20 E.H.P—the figures in each case including the motor losses. When working with hard cannel coal, the motor took from 9 to 15 E.H.P.; the power sometimes rising to 20 E.H.P. For such a load, he considered a gas-engine was admirably suited as a prime mover. At Newport, owing to the height of the sidings, it was necessary to instal transporting plant for coal and coke, and they had decided on a telpher, working on a gradient of 1 in 22. Coke was dropped into waggons of iron basket-work, which were lifted by the telpher and taken to the coke heap or elsewhere. The weight lifted was 1 ton; the speed of lifting being 60 feet, and of travelling 200 feet per minute. Hoisting the empty train consumed 3 E.H.P.; hoisting a full train, 7 E.H.P.; traversing a light train, 4½ E.H.P.; and traversing a full train, 7½ E.H.P. There was considerable advantage in using a telpher for coke, as it did not cause any frictional contact with moving machinery, which was highly objectionable. The author had stated that the chains extended by 10 per cent. in length as they became worn; and he (Mr. Canning) would like to ask him whether this was caused by the stretching of the links or wearing at the numerous joints.

Mr. D. IRVING (Bristol), referring to Mr. Atherton's remarks in contrasting the methods described in the paper with others, and on vertical retorts, pointed out that the value of the projector lay in the fact that it was applicable to existing horizontal retorts. On the subject-matter of the paper, the speaker said nothing indicated the progress of mechanical engineering more than the fact that, in eight years, the methods described by the author had become antiquated. The most advanced vertical retort system was at present in use at Bournemouth; and, as a continuous system, whereby the coal was automatically fed at the top of the retort and periodically removed from the bottom, it lent itself to very great economy in the handling of coal for gas making. The cost had been something under 1d. per ton. But the fact that Mr. Stagg, who was intimate with the working of the inclined retort plant, was so enthusiastic, spoke volumes in its favour. The question of cost had been referred to. This was a delicate subject to speak of in these competitive times. He might say, however, that the estimate for their own works had not been exceeded; and the provision of the mechanical appliances described in the paper had done much to reduce the arduous work of the men. [It was understood that Mr. Irving would send a communication in writing for inclusion in the "Proceedings."]

Mr. A. T. TANNETT-WALKER said his experience in handling coal was entirely in favour of grabs, which were cheap, simple, and efficient. In an installation handling a million tons of seaborne coal from Cardiff annually, he had decided to use grabs throughout. The chain illustrated in the paper was of very ingenious construction.†

Mr. CHARLES HAWKSLEY (London) remarked that costs were misleading unless they included every item, such as capital expenditure, upkeep, labour, insurance, &c. He therefore expressed the hope that if any statements of costs were given, all such items would be included, so that a correct opinion might be formed.

Mr. STAGG, in reply, said, with reference to the question raised by Mr. Atherton concerning the angle of inclination of the hopper, he must admit that it was insufficient—in fact, the hopper was not being used. As to the other point concerning chain-drives, he said the drive described in the paper had always acted well, and he thought there was less friction than with a chain. Of the two sections of push-plate conveyor which he had given, he infinitely preferred the semi-elliptical one (fig. 3). With regard to Mr. Canning's remarks on electrical power, he was very much interested in the figures given for the power used by the coal-breakers. He had no doubt that great and sudden variations of power did occur, as stated. Grabs were excellent things for

* In this connection, reference may be made to an article by Mr. Canning on "Gas and Electricity as Sources of Motive Power," which appeared in the "JOURNAL" for June 7, 1904 (p. 649).

† The chain referred to was designed by Mr. W. J. Jenkins, of Messrs. W. J. Jenkins and Co., of Retford, the makers of the De Brouwer plant.

handling small coal, but were useless for large coal. On the question of cost, he was quite convinced that there was a great saving in the use of machinery over hand labour, and he would not go back to hand work. He considered that the bulk of the stretching of the conveyor chains was due to wear at the joints.

FLOW OF LIQUIDS THROUGH A HOLE IN A THIN PLATE.

By M. Camille Roche.

[A Paper read before the Société Technique du Gaz.]

The exact adjustment of the liquids employed in a gas-works is of considerable importance. Washers and purifiers work well only when the washing water is properly adjusted. If too much be used, the purification is incomplete; while when too little is employed, the result is a loss of ammonia. If the vaporizers of water under the grate of the gas-furnace frequently burn, it will be found that the cause is an irregular supply of water. Water ceases to flow, the boiler becomes red hot, and the next flow of water is the cause of a fracture.

At the Rouen Congress in 1877, M. Rouget showed an extremely simple apparatus for supplying tar to furnaces by displacement of water. In physical laboratories, the Marriott bottle is an apparatus which gives a constant flow for short periods; but the writer knows of no apparatus capable of giving a constant supply for an indefinite period. All valves and cocks which have been tried have given variable results, even with highly fluid liquids, and have shown still greater variations in the case of less limpid fluids. However, an absolutely constant supply over an indefinite period has been obtained by a very simple and inexpensive device —namely, the employment of a series of supply apertures. The

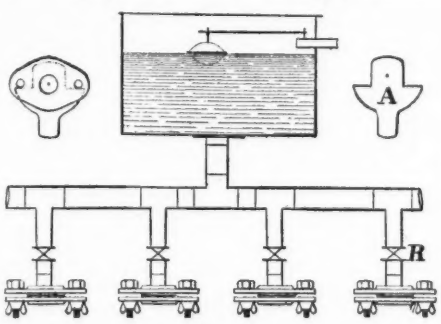


Fig. 1.

liquid which it is desired to pass through any apparatus is stored in a reservoir, in which the level is kept constant by means of a float. One of the ordinary flush type answers very well. The water is led through tubes strong enough to obviate any leakage (fig. 1). On the horizontal tube a series of crossheads are fixed, each provided with a cock, and each cock furnished with a double plate clamp secured by winged nuts. Between the two plates of the clamp a thin plate of metal A, in which is a small aperture, is placed; the size of the aperture being suitable for the particular supply required. These plates are easily made from thin zinc, or from the metal used for the drums of gas-meters.

In order to vary the supply of the liquid, a plate containing a given aperture is exchanged for another—an operation which is quickly performed by unscrewing the nuts after having closed the cock R. The same adjustment allows of the cleaning of this part of the apparatus. Apart from the regulation thus available, there is the certainty that the supply cannot be altered or tampered with in any way. The essential points in regard to this small apparatus are: (1) A constant level in the upper reservoir; (2) a large supply area in relation to the volume to be delivered in order to avoid loss; (3) the aperture in the thin plate should be open to the air, and should not be interposed between two clamps on the length of the supply pipe. The arrangement above described has been applied to various pieces of apparatus in the manner now to be briefly outlined.

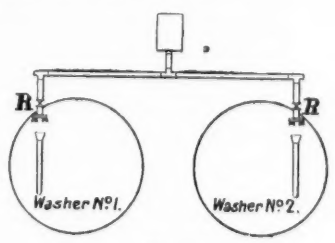


Fig. 2.

(1) "*Standard*" *Washers.*—The constant-level reservoir is placed between the two washers as shown in fig. 2. From this reservoir an iron tube communicates with two cross-heads, and descends as extra tubes to the further portions of the apparatus. The pressure of water on the apertures in the thin metal plate is 60 centimetres (24 inches). The thin stream of liquid is delivered into a funnel; and the diaphragm plate is changed as required by the manufacture and the kind of coal being used.

(2) *Adjustment of the Tar in Feeding the Furnaces.*—The arrangement is the same as that of the washers. The water flows directly on to the tar, which it displaces without mixing with it.

(3) *Watering of the Furnace Tubes.*—For want of an exact adjustment of the stream of water, a method for the cooling of the tubes by external sprinkling, such as has been suggested by M. Renaud at Toulon, is used at the present time. The aperture in the thin metal plate permits of an adjustment sufficiently exact to vaporize all the water in the tube without any reaching the top (fig. 3). The water necessary varies with the tubes, and more is required for short tubes having a less external cooling surface. Less water has to be used in the case of a furnace which is near to the door of the covering house, and therefore receives a stream of air from outside.

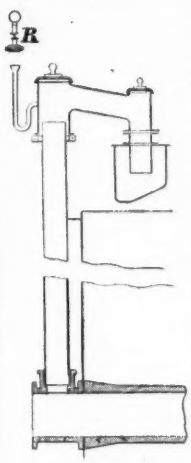


Fig. 3.

The tar, instead of depositing in hard masses on the internal walls of the tower, is viscous at the upper part of the apparatus, and can be withdrawn easily. The cooling of a tar by this method uses 0·10 litre of water per minute, or 140 litres per 24 hours. The type of cooler used by the writer for years past is that shown in fig. 3, consisting of drawn-iron tubes. These tubes are of steel only 7 mm. thick, and cost approximately the same as those of cast iron. They bear less heavily on the heads of the retorts, and have the advantage that they do not break or corrode. Their working life would seem to be indefinite. Their principal advantage is that they have an internal diameter of 200 mm.—that is to say, for the same bulk, a section equal to one-and-a-half times that of ordinary tubes of 160 mm. diameter. With a thin stream of water, these tubes never become choked. It may be added that the swan-neck plugs are joined without luting. The edges of the plug bear on a flat surface; and the weight of the plug alone is sufficient to keep it in place. A light gangway allows of the syphons by which the water enters the tubes being inspected.

(4) *Delivery of Steam under the Gas-Furnace.*—In supplying steam to the gas-furnace, great regularity is thus obtained, and considerable economy of the fuel employed for the boiler set aside for this purpose is effected. For this purpose the perforated plate method has proved most advantageous. The constant level reservoir is replaced by a steam cut-off, which regulates the pressure at 3 kilos. There is a delivery of steam from each side close to the air supply, and the latter is thus obtained in a uniform state of humidity. A sluice-valve is on the steam inlet, and below is the perforated diaphragm plate. After passing the diaphragm, the steam goes without pressure to the furnace by a large tube.

(5) *Enrichment of Gas by Benzol.*—The difficulty in this case is great, in view of the comparatively small consumption. Benzol, too, is a troublesome body to transmit by tubes, since it penetrates joints very readily, and, lastly, requires to flow with great regularity. The hydrostatic pressure above the aperture was brought to 115 mm., so as to reduce the speed of flow and make it possible

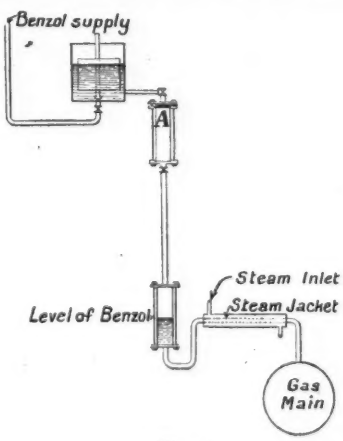


Fig. 4.

to have a convenient size of aperture. A bell reservoir, such as that for a motor carburettor (fig. 4) is kept at an absolutely exact level. On a bronze plate A is soldered a plate taken from the drum of a gas-meter, and suitably perforated. This plate carries a mantle, and may be changed in order to vary the supply as necessary. Proper precautions must be taken that all the cocks on the apparatus work perfectly tight.

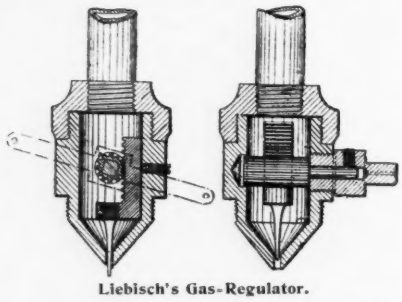
REGISTER OF PATENTS.

Gas-Burner Regulating Nipples.

LIEBISCH, R. J., of Stockport.

No. 9889; April 29, 1907.

Gas-regulating nipples used with inverted incandescent gas-burners, as at present made, are liable, the patentee remarks, owing to the heat of the burner, to stick or get out of working order; and they are also so constructed that there is nothing to indicate the position of the gas-controlling needle for the maximum or minimum flow of gas. A further fault is that the needle entirely closes the passage for the gas when in its lowest position, and thus extinguishes the light. The present invention has for its object to provide a form of nipple which will overcome these several faults.



Liebisch's Gas-Regulator.

Accordingly, the nipple is provided (as shown) with a small rack (of L formation) and a pinion; the pinion passing transversely through the body of the nipple, and the rack being capable of a longitudinal movement within the nipple. Secured to the rack is a gas-regulating needle, which projects through the gas outlet, and, according to its position in such outlet, regulates the flow of the gas. The limits of the movement of the rack determine the maximum and minimum flow positions of the needle. The pinion is connected to a finely screw-threaded stem, which screws through the wall of the nipple, and, while permitting of the rotation of the pinion, ensures of a gas-tight joint between the stem and nipple. To allow of the endwise movement of the pinion, the nipple casing is recessed opposite the end of the pinion. The gas outlet is of square formation, and the needle is round in cross-section. Therefore the needle can never fully close the outlet—the gas passing through the angular apertures between the needle and the nipple.

Combined Gas and Electric Lamps.

RHODE, H. A., of Hanover.

No. 12,260; May 27, 1907. Date claimed under International Convention, May 25, 1906.

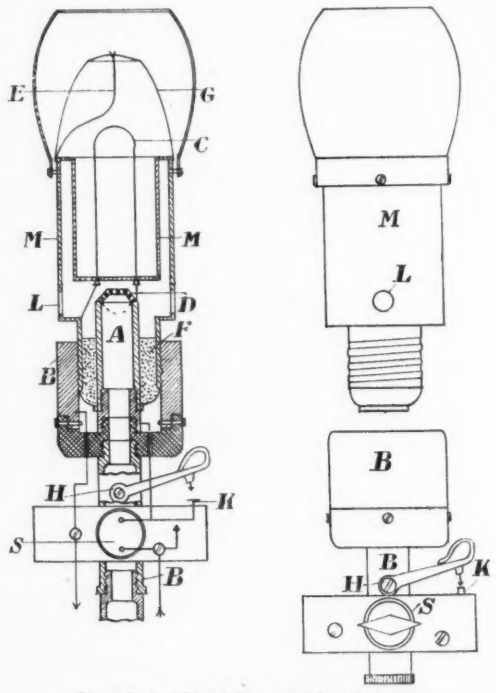
This invention relates to a lamp wherein gas and electric lighting means are combined and adapted either for use together or for independent use, and wherein the electric filament is capable of being rendered, and remaining, incandescent in the open air.

There are, says the patentee, two distinct kinds of such a lamp known. In one kind the electric filament is a conductor of the first class, while the gas-burner is of the fish-tail or like type. When the electric current is switched on, the lamp filament at once becomes incandescent and may be used alone or in conjunction with the gas when the latter is lighted, or the gas may be used alone. The gas is lighted either by extraneous means or by the incandescent electric filament, for which purpose the gas-supply cock is made part of, or combined with, the electric switch. In the other type of lamp, the electric filament is a conductor of the second class, and is heated to render it conducting by the gas issuing from a fish-tail or like burner when lighted by means independent of the electric filament. In this form, the primary object of the gas is to render the filament conducting, and generally when the latter accrues the gas is extinguished, though sometimes it is allowed to remain lighted to supplement the electric light. Such a lamp (known as an electrolytic lamp) is mainly associated with Nernst; but the lamp has been so developed that in the present commercial form of the Nernst lamp the filament is heated to render it conducting by a conductor of the first class which is cut out when the filament reaches its desired state. Here the use of gas is dispensed with.

So far as the present inventor is aware, it has never been proposed to combine electric lighting means having a filament of either of the classes mentioned with incandescent gas lighting means; and as such a combination appears desirable, he has devised an invention according to which he can employ either an electric filament of the first class or a filament of the second class heated as in the Nernst lamp, in conjunction with an incandescent gas-burner and mantle. He so combines them that the filament in the first case, or the heater in the second case, ignites the gas.

The illustration represents electric lighting means having a filament of the first class and incandescent gas lighting means of the upright type—a central sectional elevation of the lamp with the components assembled for use; an elevation of the lamp proper separated from its fitting or support; and an elevation of the fitting.

C is the electric filament, and A, G, E the burner tube with perforated gas-nipple D, mantle, and mantle support; the whole being supported by a fitting B fixed on the gas-supply pipe and carrying the cock H for the gas and the switch S for the electric current—all of any appropriate construction and arrangement. M and M^1 denote two combined cylinders; the outer one being adapted for securing to the fitting B, and being provided with a plug F, of insulating material, through



Rhode's Combined Gas and Electric Lamp.

which the burner tube passes to communicate with the space between the cylinders, and to which air is admitted through orifices L in the outer cylinder. The space between the cylinders is covered at the top by a perforated disc constituting the burner-head of the gas-lighting means. The gas-cock H is provided with a lever combined with the switch S, so as to operate it also in any suitable manner. According to the example, the lever is provided with a finger for co-operating with a spring contact K of the switch, and which, in turn, co-acts with a rigid contact connecting with the source of current.

Assuming the parts are assembled as shown in the section, then no illumination is obtainable. However, supposing the lever of the cock H is depressed sufficiently, the gas flows through the fitting B to the tube A into the space between the cylinders M M^1, where it mixes with the air entering by the openings L; and eventually the mixture escapes into the region of, and is ignited by, the filament C rendered incandescent by the closing of the electric circuit. Now if the gas-cock lever be raised so that its finger is clear of the contact K, the latter springs from its complementary contact, and thus the electric circuit is broken and the filament C is extinguished. But the gas remains lighted. Should, however, the electric light only be desired, the switch S is suitably operated, or the cylinder M and the tube A are unscrewed from the fitting B and the whole applied to a fitting of any convenient type with appropriate contacts for co-acting with the conducting portions of the tube A and cylinder M.

Regulating Devices for Gas-Burners.

DEUTSCHE CONTINENTAL GAS-GESELLSCHAFT, and MUCKE, F., of Dessau, Germany.

No. 15,362; July 3, 1907.

This device for regulating the supply of gas to the burners of heaters for liquids, is arranged in the pipe leading to the burner, and is brought out of the throttling position as soon as the passage supplying gas to the burner is open. The throttling device is displaced by means of a membrane or similar actuating part connected with it. The regulating device has for its object to allow only a low burner flame to form in the first place when the gas-cock is opened, and which is increased to its full height only after the displacement of the throttling device. "By this means an explosive kindling of the flame and the formation of soot are avoided."

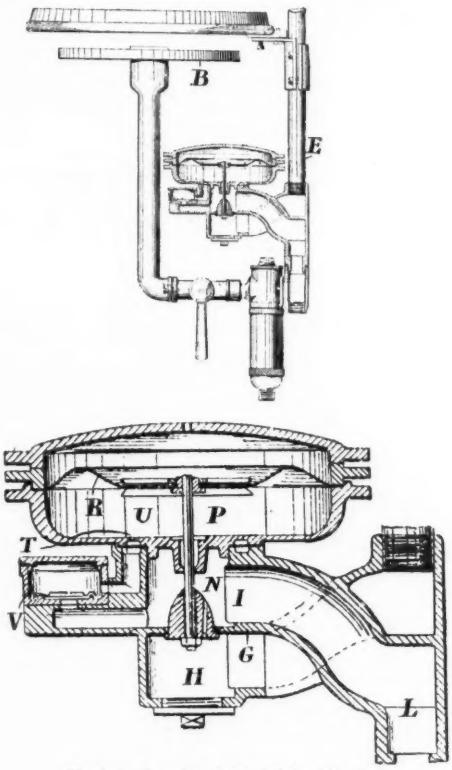
The throttling device (p. 337) is arranged in a casing divided into two chambers H and I by a partition G. The chamber H communicates with the gas-supply pipe E, while the chamber I is connected with a pipe L leading to the main burner B. The opening in the partition is covered by a valve N (acting as a throttling member) provided with a bore. The valve stem P is rigidly connected with a membrane R.

A retarded opening of the valve is obtained by a special formation of the valve, which broadly presents the form of a parabola, has a rounded conical top, and is cylindrical at its lower part for about one-third of its length, so that during the period of descent of this part no increase in the amount of gas supplied to the small burner flame can take place.

In the conduit T, between the space beneath the membrane and the casing of the throttling valve, is interposed a second valve consisting of a small loose aluminium plate V (separating the two chambers) provided with a bore. The membrane R is loaded in accordance with the gas pressure.

The gas, entering through the supply pipe E, first of all fills the chamber H, communicating therewith, then flows through the bore in the throttling valve N into the other chamber I, and through the pipe L to the burner B, in order to become kindled at a pilot flame. The quantity of gas flowing through the bore is calculated in such a manner that the small flames of the burner attain a height of from 8 to 10 mm., "whereby the kindling is effected quietly and without the formation of

soot." The small flames burn for about five seconds at the height stated. During this time, the column of cold air in the interior of the water-heating apparatus or in the flue is expelled, and the burner flames, "which subsequently gradually become larger, no longer encounter any resistance from this air, and are able to develop entirely free from soot."



Mucke's Regulated Gas Water-Heater.

The gas in a third chamber U, underneath the membrane R, flows slowly through the passage T into a fourth chamber, and thence through the bore W in the small aluminium plate V into the chamber I and the pipe L leading to the burner. During this period, the membrane R, which is weighted according to the gas pressure, descends, as does also the throttling valve body N.

Owing to the provision of the cylindrical portion at the lower part of the valve body, "the result is obtained that at the beginning of the descent of the valve no increase in the quantity of the gas supply to the small burner flames can take place; and it is only when the valve body has descended so far that the parabolic or tapering part enters the opening of the seat that more gas gradually reaches the smaller burner flames until they have developed their full height." The device now acts as a pressure regulator; the total height of the flames being dependent upon the loading of the membrane R.

On closing the water-cock (whereby in most cases the supply of gas to the burner is simultaneously cut off), the membrane R, and with it the throttle valve body N, ascend quickly into their original positions, as in this case the plate V, which acts in the manner of a non-return valve, is raised from its seat and gives free access for the gas to the chamber U below the membrane.

Manufacture of Gas.

RIES, HANS, of the Munich Gas-Works.

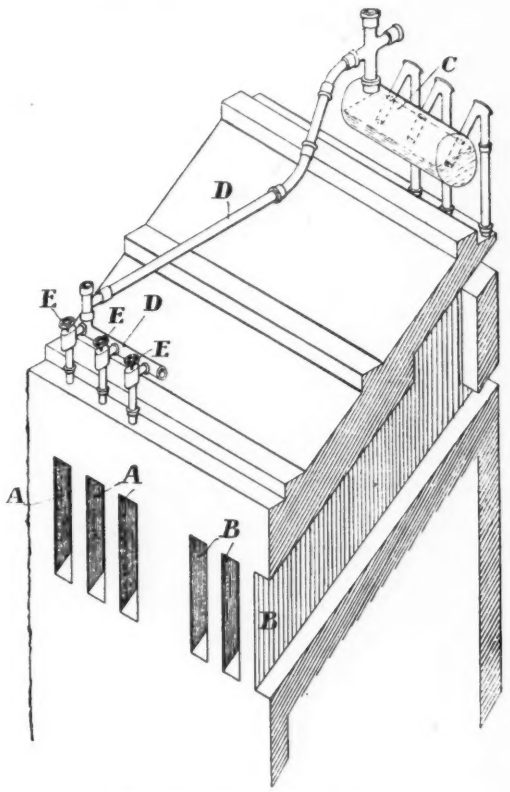
No. 26,593; Dec. 2, 1907.

This invention has for its object "to avoid the decomposition of the higher quality of gas which is produced in the retort during the initial stages of distillation."

In the manufacture of gas, especially that for lighting purposes, the patentee points out, the gas which is formed in the earlier stages of distillation is of high grade—being rich in heavy hydrocarbons—and is easily decomposed when it comes into contact with the highly-heated walls of the retort. To prevent this occurring, it has hitherto been proposed to expel the richer gas produced during the early stages of distillation by increasing the rate of flow of the gas through the retort; a separate gas—such as hydrogen or carbon monoxide, or a mixture of them—being introduced from a separate installation for the purpose.

According to the present invention, during the initial stages in the production of the gas there is introduced into the retort a gas poor in hydrocarbons, obtained from one or more of the retorts wherein the production of the gas has reached or almost reached its last stages. "No separate installation for the production of a propelling gas is thus necessary."

For carrying out the process, apparatus such as is illustrated in perspective may be employed. The retorts A are connected, either separately or in groups, to the retorts B by the employment of an intermediate chamber C and one or more pipes D. The arrangement is such that the separate retorts A can be shut off as required from the gas-supply pipe D by means of valves or the like operated by hand wheels E. By means of the communicating pipes or passages, gas can thus be permitted to flow from one or more selected retorts to one or more other selected retorts, according to the stages of distillation going on in the retorts.



Ries' Rich and Poor Gas Producer.

The present process is said to have important advantages over any process hitherto suggested, wherein the high-quality gas laden with heavy hydrocarbons is diluted by means of water gas, and which involves the necessity of a plant for the generation of water gas, obviated under the present process. Further, the inventor mentions that, in another process which has been proposed for use in the treatment of low-grade material for the production of gas, the retorts were arranged in couples and used alternately; so that a gas was being produced in one retort or chamber while the other chamber was being cleared of gas by means of the gaseous products escaping from the first chamber.

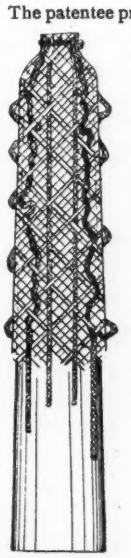
According to the present invention, the intermittent admission of gas which is poor in hydrocarbons into these retorts, in which the process of distillation and the production of gas has only just commenced, is greatly dependent on the time of working the process, "which must in any case be watched, in view of the necessity for always charging the retorts in a uniform manner."

Manufacturing Incandescent Gas-Mantles.

ROSS, E., of Barmen, Germany.

No. 6026; March 18, 1908.

The patentee proposes to manufacture mantles on a braiding machine, so that a tubular fabric may be obtained more or less conical at its points, provided with strong threads, which increase the durability of the mantle, especially after the burning-off process. The invention "involves the method of removing the slings of the stronger threads, which, being well known, are not part of the claim."



Ross's Mantle.

As shown, the mantle foundation has threads which cross each other as in ordinary braid and form meshes which are elastic in structure, so that the mantle is not exposed to breakage. To increase the strength of the fabric, there are arranged within it, and in length direction, a number of stronger threads, which are inserted in the foundation during its manufacture on the braiding machine and lie loosely therein. By preference, the tubular braid is made as narrow as possible, and is broadened afterwards for the purpose of impregnating it with the earth solution. The operation of enlargement is carried on by means of a conical bar on which the fabric, which is provided with a head, is simply stuck. On the bar the threads assume a diagonal direction and an approximately rigid, though elastic, formation, and they produce a smooth outer surface, with the exception of the stronger threads, which, being fixed in the head, appear very unsymmetrically in the fabric—forming partly slings or eyes which are afterwards drawn down until they assume a smooth position, which they will keep during and after the burning-off process.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Koppers' Inclined Coke-Ovens.

SIR,—I notice in last Tuesday's "JOURNAL" (p. 235, fig. 3) Koppers' patent inclined coke-ovens, and learn that they are erected at the Bochum and Vienna Gas-Works. I may point out that I applied in September, 1902, for a patent for an installation on somewhat similar lines for carbonizing in bulk; and the setting was put into operation at my Company's Flathouse works during the same year.

J. D. ASHWORTH,
Portsmouth, July 29, 1908. Engineer and General Manager, Portsea Island Gas Company.

Mr. Bywater's Paper on Refractory Material.

SIR,—You were good enough to publish in your issue of July 21 (p. 177) some figures that I prepared with a view of correcting Mr. Bywater's statement that "the annual cost of refractory material per ton of coal carbonized usually ranges from 4d. per ton of coal in the case of direct-fired to 10d. in gaseous-fired settings" (see "JOURNAL," June 23, p. 838).

Mr. Bywater, in your issue of July 28, refers to these figures as hypothetical, and suggests an omission that he regards as serious. He also states that the costs given in his paper are *actual* figures for various works carbonizing nearly three-quarters of a million tons of coal annually, and include all charges incurred in the repair and maintenance of retort-settings.

I regret that the locality of the works is not given, and that the period is not stated over which this cost has been ascertained. I am, however, enabled to also furnish ascertained figures extending over the four financial years 1905, 1906, 1907, and 1908. The figures are for the gas undertaking of the City of Manchester; and the average cost per ton of coal is 4·05d. This figure includes all labour and materials used within the arches, including settings and regenerator furnaces. The figures are given to me in a letter dated July 22, from Mr. J. G. Newbigging, in reply to mine asking for permission to refer to their accounts; and I am glad to acknowledge his kindness in tabulating the four years' figures, and his courtesy in allowing me to make use of them.

The basis of Mr. Bywater's paper, expressed in the concluding paragraph (see "JOURNAL," p. 838), is, if I understand it rightly, the cost per ton of coal carbonized; and at present the difference between his calculations and mine, for the United Kingdom, amount to £400,000 per annum. For the works, or group of works, to which he makes reference, and at which the ascertained cost is given as 10d. per ton of coal, there would appear to be an expenditure of over £18,000 per annum in excess of the ascertained cost at Manchester. This would seem to indicate, if I may quote the author's own words ("JOURNAL," p. 840), "that they had something they did not quite understand, and they were getting into difficulties."

I do not agree that there is any omission in my hypothetical figures; but my calculations are, as stated, for examination and criticism, and I am glad to think they have stood it pretty well. I should have perhaps added figures for inclined retorts; but 4d. per ton is a perfectly safe figure for these.

In a further letter in your next issue, I hope I may be allowed to refer to the author's remarks on machine-made retorts.

Dibdale Works, Dudley, July 31, 1908. W. P. GIBBONS.

The Feld Centrifugal Gas-Washer.

SIR,—On opening the "JOURNAL" this week, I was rather surprised to see an old friend, in the form of a diagram representing the Feld washer, which brought to my recollection the design—almost identical—of my centrifugal gas-washer as published in your columns in connection with the meeting of the North British Association of Gas Managers, in July, 1888. There is really no difference whatever in the two appliances, either as to outward appearance (mine being built of riveted iron or steel plates) or in the object of the internal arrangements. Both aim at forming a fine spray, for reasons I then stated—in fact, the falling water in my design continues to be kept in a state of fine spray for the whole height of each apparatus. I see no benefit whatever in the complications of several tiers of troughs, and small chokeable overflow-pipes. My apparatus would certainly require less power to drive it.

The writer of the article marvels that the application of the principle had not occurred to anyone before. If you refer to the "JOURNAL" for the period I mention—twenty years ago—you will recognize in the diagrams on p. 291 of the number for Aug. 14, 1888, the likeness of the "father" to Mr. Feld's adopted child. My apparatus will not give any back-pressure, and could even, by slight modification of the wings spirally (also an old design of mine), relieve pressure by assisting the flow of gas forward. The gas inlet is shown at the bottom of the washer, and the outlet at the crown of my apparatus, just as in Mr. Feld's. The water-spraying tubes radiate from the central overhead tank which receives the liquor from the pumps, pass through the shell of the tower, and have a cap on each end, on the outside of the washer, for removal for purposes of clearing the water-holes.

I thus claim to be the originator of the idea for the extraction of tarry matter centrifugally while at a high temperature, to prevent loss of illuminating power later on by contact of the gas with cold tarry surfaces, and also of the centrifugal gas-washer, as put into use after cooling of the gas to a proper temperature; the liquor having been entirely freed by my apparatus from the tarry matter which prevents intimate contact of the gas with the liquor, as explained in my paper to the North British Association, and so enormously reducing the efficiency of washers by passing into them coal gas in process of manufacture, which had been imperfectly clarified and cooled before entering a washer.

In Mr. Feld's design and description, no mention is made of making sure that the gas has been previously properly condensed and clarified before entering the washer; and I now take this opportunity of warning intending users of the plan I designed so long ago that, should gas be admitted to the centrifugal washer in such a condition as to cause the spraying liquid and mist to become intimately churned up with liquid hydrocarbons condensed out during periods of cold weather, the illuminating power of the washed gas will be seriously reduced. The loss will, of course, be greatest while manufacturing gas of high illuminating power.

St. Cyr, Ceres, Cupar, N.B., July 29, 1908. W. KEY.

PARLIAMENTARY INTELLIGENCE.

UNOPPOSED BILLS.

The Unopposed Bills Committee of the House of Lords, presided over by Lord ONSLOW, had before them last Tuesday two Bills containing matters of interest to our readers.

Monmouth Provisional Order Bill.

This was a Bill confirming an Order of the Local Government Board making various alterations in Local Acts for the borough of Monmouth, appointing a Government Auditor for the Corporation accounts, and in various ways putting the finances of the Corporation in a reasonably satisfactory condition.

Mr. HERBERT BOYCE, representing the Local Government Board, said one of the things the Board insisted upon was the Government audits, as the state of things that had prevailed hitherto in Monmouth was of the most careless and unsatisfactory character.

The CHAIRMAN asked if Monmouth was a very poor place?

Mr. BOYCE said it might be poor, but the condition now was due mainly to mismanagement. For instance, in 1902 they borrowed for six years the sum of £10,000 on the guarantee of Lord Llangattock. Five of the six years ran out without the least provision being made in the way of a sinking fund. Again, in connection with the joint sewerage scheme, they had from time to time paid away £45,000 to the Contractors, and there was not a single account to show what the money was for. The only thing they had was a day cash-book, showing amounts paid, and certificates by the engineers certifying that certain amounts should be paid. No member of the Council seemed to have made any independent inquiry as to the scheme, or whether the work represented by these payments had been carried out. It was a state of affairs that had never previously come under the notice of the Board's Inspector.

Lord BALFOUR thought there was no further need for justification of the Local Government Board's action in imposing a Government audit on the town.

The Bill was ordered for third reading.

Barry District Provisional Order.

Another Bill was to confirm a Provisional Order granted to the Urban District Council of Barry in respect of their water undertaking. The Order increases the powers of the Council, and authorizes them to purchase by agreement (but not otherwise) lands not exceeding 20 acres in extent for the purposes of protecting from pollution or contamination the area, springs, and other sources from which their supply of water is obtained. The Bill was passed for third reading.

Hull Water-Works Management.

At a luncheon which was held in connection with the annual inspection of the Hull Water-Works, reference was made to the resignation of Mr. F. J. Bancroft, the Engineer, who is leaving to take charge of the Barnet District Gas and Water Company's undertaking. The Mayor (Alderman Feldman, J.P.), in rising to propose the toast of "Mr. Bancroft," said that he was making an innovation which he believed would be forgiven in introducing speeches at the gathering; but he felt they could not allow Mr. Bancroft to leave them without expressing to him their goodwill. In him, they had a man strong in will-power, full of courage and determination, and ready to give a lead when required. He need not remind them of the former history of the water undertaking; but they would all agree that since Mr. Bancroft had been with them they had had more restful times, and great success had attended their enterprise. They looked upon the water-works undertaking as the buttress of municipal enterprises, and not the butt of public censure or ridicule. They were able to allot yearly a portion of the profits to the reduction of the rates. In a very large measure, this success had been attained through the wise efforts of Mr. Bancroft. They had learned to admire his indomitable perseverance and courage. The city owed him a deep debt for having done his duty so efficiently in respect not only to the Committee, but the staff associated with him. In his new position, they wished him prosperity and success. Mr. Livingstone supplemented the Mayor's remarks. Mr. Bancroft, in reply, said that during the twelve years he had been in Hull he had been loyally supported. The first years were very anxious ones, and it was gratifying for him to know that his efforts had been appreciated. He wished prosperity to the Corporate schemes, and to the good old city of Hull.

Price of Gas for Power Purposes at Tipton.—The Tipton Gas Committee have decided that from the close of the present quarter the charge for gas used for power purposes shall be as follows: Under 50,000 cubic feet, 2s.; from 50,000 to 100,000 cubic feet, 1s. 9d.; and over 100,000 cubic feet, 1s. 6d. per 1000 cubic feet.

LEGAL INTELLIGENCE.

COMPENSATION FOR LAND FOR A RESERVOIR.

In the "JOURNAL" for the 21st ult. (p. 182), we reported the proceedings in an appeal from a decision of Mr. Justice Bray in the matter of an arbitration between Mr. B. Lucas and the Chesterfield Gas and Water Board. At the close of the hearing, an indication was given of the views of the Court, but formal judgment was reserved. This was delivered last Wednesday.

Lord Justice VAUGHAN WILLIAMS, after stating the circumstances (reading a portion of the special case submitted to the Court, and a passage from the judgment of Mr. Justice Bray), said he agreed with the learned Judge that the fact that no buyer of the land for reservoir purposes could be found except one who had parliamentary powers, did not prevent the special value on account of adaptability being marketable, not only on the ground stated in the case of *Ossalinski v. Corporation of Manchester*, but also because the fact that the Board themselves might become a possible purchaser, and would give a special price for the land, ought to be considered. He likewise agreed with the learned Judge that the land adjoining large works would often have considerable value because the owner of the works might require additional land, and would be willing to give a high price because it adjoined his premises. Why should not the land in the case before them have a special value because, if the Board desired to build a new reservoir, this was the most convenient site for it? His Lordship then read the questions put to the Umpire by the Court of Appeal, and his answers to them, as well as several passages from the judgment of Mr. Justice Grove in the Ossalinski case, and went on to say that in the present instance neither side took exception to the law as there laid down in reference to special adaptability being an element which the probability of purchasers requiring land for such a purpose gave to the land. But it was said that the element which the Arbitrator might take into consideration was not the fact that the land had been taken, and that the probability had been realized by the promoters having obtained special powers to take the land in question, but only the value of the probability as it existed before the promoters had obtained their powers; and that these values could not be the same. It was further said that the Umpire, by his answers to the questions sent to him, had plainly shown that, in his judgment, the contingent value of the probability and its realized value, by reason of the promoters having obtained parliamentary powers to take the land, were identical. He thought this was so, and that in this respect the Umpire had gone on a wrong basis. The award ought therefore to be sent back to him in order that he might value the possibility of the site coming into the market as being required for the enlargement of the water-works, and not on the basis of a realized possibility on account of the promoters having obtained compulsory parliamentary powers. The value of the possibility, as stated by Lord Collins in *Gough v. Aspatria, Silloth, and District Water Board*, was a question entirely for the Arbitrator. It might be that the adaptability of the land for the purpose of enlarging the reservoir was so unique that he would give a value little less than that which he would allow if dealing with the realized possibility; but, in his (his Lordship's) opinion, he ought to value the possibility and not the realized possibility. He entirely rejected the contention, on behalf of the Board, that because the Board itself owned a portion of the land essential to the construction of a reservoir for which the land compulsorily taken was specially adaptable, and because the Board could always have refused to combine with the other owners of the land, therefore the adaptability of Mr. Lucas's land could not be taken into account as an element to be considered in assessing the compensation. The argument seemed to be that because the Board had obtained powers to construct the reservoir, the possibility of a purchaser requiring the land had come to an end. The result was that the award would have to go back to the Umpire, in order that he might value on the basis he (his Lordship) had pointed out.

Lords Justices MOULTON and BUCKLEY agreed.

It was decided that the award must go back, and that, as the appellants failed in their main contention, they must pay the costs.

The Charge for Water for Chester Workhouse.

In the Court of Appeal last Tuesday, the Master of the Rolls and Lords Justices Farwell and Kennedy had before them an appeal from an order of Mr. Justice Coleridge in Chambers, refusing to review a taxation of the costs in this action brought by the Chester Water Company against the Guardians of the Chester Union on objections carried in by the plaintiffs. Mr. Atkin, K.C., and Mr. Randolph appeared for the Company; Mr. Lush, K.C., and Mr. Ellis Griffith represented the respondents. Mr. Atkin having reminded the Court as to the nature of the action, the decision of Mr. Justice Jelf in the Court below, the variation made in the order by the Court of Appeal, as recorded in the "JOURNAL" for Feb. 18 last (p. 423), and the directions given as to the payment of costs, explained that when the matter came before the Taxing Master he had taken upon himself to disregard the order of the Court, and had disallowed to the plaintiffs a large amount of costs to which under the order, as he submitted, they were entitled. Mr. Lush contended that what the Taxing Master had done was in accordance with what had been said in the Court of Appeal. But he could not persuade their Lordships to take his view. The appeal was accordingly allowed, with costs in that Court and in the Court below—the matter to go back to the Taxing Master with a direction to tax the costs in accordance with the order of the Court.

Melbourne Metropolitan Gas Company.—Messrs. John Terry and Co., the agents for the Metropolitan Gas Company of Melbourne, have received cable advice informing them that the Company's profits for the half year ending the 30th of June were £66,850. A dividend of 5s. per share has been declared for the six months, a sum of £24,000 added to the reserve fund, and a balance of £2600 carried forward.

MISCELLANEOUS NEWS.

BIRMINGHAM GAS TO BE REDUCED IN PRICE.

At their Meeting last Tuesday, the Birmingham City Council adopted the recommendation of the Gas Committee to reduce the charges for gas consumed after the Michaelmas index readings of the meters, as follows: For lighting and heating purposes, in one premises: Under 50,000 cubic feet per quarter, from 2s. 6d. to 2s. 4d. per 1000 cubic feet; between 50,000 and 250,000 cubic feet per quarter, from 2s. 3d. to 2s. 2d.; between 250,000 and 1,000,000 cubic feet per quarter, from 2s. to 1s. 11d.; for 1,000,000 cubic feet and upwards per quarter, from 1s. 10d. to 1s. 9d., less 5 per cent. discount for prompt payment. For motive power purposes: Under 100,000 cubic feet per quarter, from 1s. 10d. to 1s. 9½d. per 1000 cubic feet; 100,000 cubic feet per quarter and upwards, from 1s. 7d. to 1s. 6½d., less 5 per cent. discount for prompt payment. For supplies of gas through prepayment meters: With gas fittings and cookers free, from 26 to 28 cubic feet per penny; with cookers free, from 31 to 33 cubic feet per penny.

Alderman Sir HALLEWELL ROGERS, in presenting the Committee's report, remarked that it was very gratifying to be able to recommend a reduction in price. At a previous meeting of the Council, one or two members urged the advisability of maintaining the price of gas and contributing an increased sum towards the rates, on the ground that the rates at present were very high, and also that any decrease in the price of gas would be shared by consumers not only in the city but outside in the area of gas supply, whereas in regard to the water only those within the city shared the loss of the £65,000. He was convinced that such arguments were unbusinesslike, and that it would be wrong and unfair to require gas consumers to bear any increased proportion of the rates because in their particular trade, or in their homes, they required to use gas. It would be against the interests of the ratepayers, who were the shareholders in the gas undertaking, to keep the price for gas unduly high. He reminded the Council that during the last seven years they had increased the gas contribution in aid of the rates from £30,557 to £61,313; and during this time considerable reductions had been made in the charge for gas to large consumers, especially those for engine purposes. They thought it right to propose a reduction, not only of 1d. per 1000 cubic feet to all consumers, but an extra 1d. to the smaller ones, who, they thought, were now entitled to the concession, and who represented 95 per cent. of the total consumers on the books. The proposed charges would, if adopted, be the lowest in the history of the undertaking; ranging, as they did, allowing for cash discount, from 1s. 8d. to 2s. 2d. per 1000 cubic feet of gas used for lighting and heating, and as low as 1s. 5d. per 1000 feet for that used for motive power purposes. Nor had the claims of the consumers who obtained their gas through penny-in-the-slot meters been overlooked, as the reductions made equalled nearly 2¾d. per 1000 cubic feet on the lowest scale. When they last reported to the Council, representations were made by one or two members in regard to reducing the price of gas for heating purposes. This proposal would have due consideration, but at present the Committee did not think it would be fair or wise to reduce the price of gas for heating, because, though it would be helping the manufacturer, there were other people who used it for trade purposes; and it would be difficult to arrange a system of prices without altogether altering their present standard.

Alderman CLAYTON, who seconded the motion, remarked that when the gas undertaking was transferred to the Corporation in 1875, Mr. Chamberlain said, as an inducement to the ratepayers accepting responsibility, they could look forward ultimately to £40,000 or £50,000 being given in aid of the rates. This, and more than this, had been carried out. The present was a favourable opportunity for reducing the price of gas in the way suggested, considering the very strong financial position of the Gas Committee. Since the annual report of the Committee was issued, "Field's Analysis," which was the standard authority with regard to gas-works, had been published for the past year. He would like to point out the position they held with regard to other great gas undertakings in the country, in respect to the amount of capital per 1000 cubic feet of gas sold. Taking the great London gas-works, the amount employed was 11s.; and in the Suburban companies in the neighbourhood of London, it was 10s. 3d. Taking the gas companies in the country, he had made a considerable selection of both large and small, and the sum was 9s. 10d. per 1000 feet; whereas that employed by the great municipal corporations was 10s. 10d. On the face of them, these figures looked unfavourable to corporations. But in the analysis, the compiler had introduced additional figures, which put a different complexion on the matter; for in consequence of the payment of the debt from year to year, the average of the corporation accounts was only 7s. 9d.—which was a very favourable figure. In the case of Birmingham, at the present time the figure was only 6s. 1d. He considered this was a great point for the consideration of those who said corporations were not capable of managing gas-works or other trading departments efficiently. Then, again, they had controlled their gas-works 33 years. Manchester had had theirs 30 years longer; and in Manchester, with the advantage of 60 years' ownership, the amount of capital now stood at 4s. 9d. only.

The reduction having been agreed to, the following increases in salary were confirmed: Mr. F. J. Bywater, Engineer in Charge, Saltley Works, from £375 to £425 per annum; Mr. W. Chaney, Engineer in Charge, Nechells Works and Adderley Street Works, £525 to £625; Mr. John Foster, Engineer in Charge, Windsor Street Works, £600 to £650 per annum; and Mr. W. B. Davidson, M.A., Ph.D., Chief Chemist, from £375 to £425 per annum.

The Recent Typhoon at Hong Kong.—Our readers may remember that Hong Kong was recently visited by a typhoon, which caused considerable havoc. We are pleased to learn from the Secretary of the Hong Kong and China Gas Company, Limited (Mr. F. G. Barrett), that, according to a cable received from the Engineer last Tuesday, the damage to the Company's property is not serious.

GASLIGHT AND COKE COMPANY'S ACCOUNTS.

[For the Half-Yearly Report, see p. 300.]

The accounts of the Company for the six months ending June 30, to be submitted with the Directors' report on Friday, consist of the usual statements, from which we take the following particulars.

The statement of capital (stock) sets forth that the total paid up is £9,466,500; added on conversion, £12,176,565—total amount authorized, £21,643,065. Deducting the amount redeemed, £81,655, the total amount of the Company's existing capital powers is £21,561,410. The statement of loan capital stands thus: Total paid up, £2,844,000; added on conversion, £1,479,975; unissued, £750,000—total amount authorized, £5,073,975.

The capital account shows receipts (with premiums, £1,586,807 11s. 9d.) to the amount of £27,472,192 11s. 9d.; a sum of £21,045 having been redeemed during the half year. The expenditure is shown in the following items:—

Expenditure to Dec. 31, 1907		£13,488,832 18 3
Expenditure during the half year to June 30, 1908—viz.,		
Buildings and machinery in extension of works	£4,372 0 3	
New and additional mains and service-pipes	16,575 12 8	
Do. do. meters	11,679 15 3	
Do. do. stoves	6,980 4 10	
		39,547 13 0
		£13,528,380 11 3
By sale of surplus land	£14,954 5 9	
By depreciation of plant	7,566 5 8	
By depreciation of meters and stoves	33,980 12 6	
		56,511 3 11
Total expenditure		£13,471,869 7 4
Nominal amount added on conversion		13,656,540 0 0
		£27,128,409 7 4
Deduct amount of capital redeemed under Company's Act of 1903		81,655 0 0
		£27,046,754 7 4
Balance of capital account		425,438 4 5
		£27,472,192 11 9

The balance applicable to the redemption fund and to dividend on the ordinary stock is £765,984 19s. 10d.; and the following statement shows how it is proposed to appropriate it:—

June, 1907.			
£229,953	..	Net balance brought from last account	£349,551 0 9
421,206	..	Net revenue for the half year	416,433 19 1
£651,159			£765,984 19 10
10,000	..	Contribution to redemption fund	10,000 0 0
(£4 8s. per cent.)		Dividend on the ordinary stock—	
£334,017	..	£4 10s. 8d. per cent. per annum on £15,161,545	343,661 13 9
150	..	Forfeiture for deficiency in illuminating power	25 0 0
£305,991	..	Balance carried to next account	£412,298 6 1

The following is the revenue account:—

Expenditure.

June Half Year, 1907.		£ s. d.	£ s. d.
£556,772	Manufacture of gas— Coal into store	662,199 6 2	
80,540	Oil ,, less value of oil tar	82,532 0 11	
33,604	Coke and breeze used in the manufacture of carburetted water gas	37,679 19 8	
14,917	Salaries of Engineers and other officers at works	15,032 10 0	
104,618	Wages	96,968 3 3	
22,625	Purification, including £9896 16s. 2d. for labour	17,053 15 6	
212,228	Repair and maintenance of works and plant, materials and labour, less received for old materials, £9117 7s. 10d.	183,849 6 2	
	Distribution of gas—		1,095,315 1 8
43,155	Salaries and wages of officers (including rental clerks)	45,006 2 11	
56,892	Repair and maintenance of mains and service-pipes, &c.	53,504 7 3	
46,469	Repair and renewal of meters	52,088 19 10	
50,727	,, ,, stoves	48,371 0 0	
29,258	Gas fittings, including labour (automatic meter supplies)	31,044 18 3	
			230,015 8 3
19,520	Public lamps—lighting and repairing	..	19,859 6 7
	Rents, rates, and taxes—		
5,850	Rents payable	5,859 1 0	
136,523	Rates and taxes	138,464 9 10	
			144,323 10 10
	Management—		
2,750	Directors' allowance	2,750 0 0	
202	Company's Auditors and Assistant	202 2 0	
7,911	Salaries of General Manager, Secretary, Accountant, and clerks	8,167 7 5	
22,880	Collectors and cashiers	23,017 16 11	
5,338	Stationery and printing	5,762 9 7	
4,781	General charges	6,436 16 6	
			46,336 12 4
..	Parliamentary charges	..	389 10 7
1,157	Law charges	..	1,375 14 11
5,44 4	Bad debts	..	7,525 10 5
500	Depreciation fund for works on leasehold lands	..	500 0 0
24,379	Annuities, including contribution to officers' superannuation fund	..	24,714 6 8
1,322	Workmen's compensation account	..	2,164 2 11
	Public officers—		
1,245	Gas Referees and Official Auditor	1,243 7 1	
612	Public testing-stations	616 14 3	
			1,860 1 4
£1,492,189			1,574,359 6 6
628,993	Balance carried to net revenue account		621,782 18 8
£2,121,182			2,196,142 5 2

Receipts.

June Half Year, 1907.		£ s. d.	£ s. d.
	Sale of gas—		
£1,520,595	Per meter, at 2s. 10d. and 2s. 5d. per 1000 cubic feet	1,482,772 2 8	
68,773	Public lighting and under contracts	74,878 4 7	
			1,557,650 7 3
£1,589,368			
..	Rental of meters (ordinary)	..	29,028 19 10
30,326	Rental of stoves	..	41,245 11 9
58,545	Rental of fittings	..	64,359 13 7
	Residual products—		
£271,912	Coke, less £35,434 18s. 8d. for labour, &c.	327,794 2 3	
13,697	Breeze, less £6238 17s. 6d. for ditto	21,384 4 7	
47,929	Tar and tar products	52,154 19 2	
95,522	Ammoniacal liquor and sulphate of ammonia	97,629 13 9	
			498,962 19 9
£429,660			
£4,568	Rents receivable		4,614 3 0
315	Transfer fees		280 10 0
£2,121,182			2,196,142 5 2

The three statements relating to the reserve, insurance, and depreciation funds, stood as follows on the 30th of June: Reserve fund, £65,037; insurance fund, £114,817; depreciation fund, £67,710. The insurance fund was drawn upon to the amount of £1800 to satisfy claims arising out of the explosion in May's Yard, Holborn, on July 30, 1906.

The following statements relate to the working:—

Statement of Coal Used, &c.

Description of Coal.	In Store Dec. 30, 1907.	Received During Half Year.	Carbonized During Half Year.	Used During Half Year.	In Store June 30, 1908.
	Tons.	Tons.	Tons.	Tons.	Tons.
Common	225,384	822,313	891,459	2,352	150,886
Cannel	7,296	12	1,909	..	5,399
Total	232,680	822,325	*896,368	2,352	156,285

* In addition to this quantity of coal, 6,857,964 gallons of oil and 58,860 gallons of spirit were used during the half year.

Statement of Residual Products.

Description.	In Store Dec. 31, 1907.	Made During Half Year.	Used During Half Year.	Sold During Half Year.	In Store June 30, 1908.
Coke—tons	9,728	554,855	125,519	394,976	44,088
Breeze—tons	8,671	91,105	13,134	76,572	10,070
Tar, from coal only—galls.	891,907	8,997,361	9,233,073	41,183	615,012
Ammoniacal liquor—butts	27,895	267,658	279,778	..	15,775

Statement of Gas Made, Sold, &c.

Quantity Made.	Quantity Sold.		Total Quantity Accounted for.	Number of Public Lamps.
	Public Lights and Under Contracts. (Estimated.)	Private Lights (per Meter).		
Thousands.	Thousands.	Thousands.	Thousands.	
*12,270,924	463,857	10,705,241	11,314,934	49,043
†12,156,798	465,541	10,749,443	11,360,826	49,000

* Including 2,420,351,000 cubic feet of carburetted water gas. † June half year, 1907.

The remaining statement is the balance-sheet, which gives the value of the stores in hand at the close of the half year as follows: Coal, £118,574; oil and petroleum spirit, £55,318; coke, £29,399; tar and ammoniacal liquor and products, £80,925; and sundries, £222,171. The figures this time last year were: Coal, £92,804; oil and petroleum spirit, £36,095; coke, £7485; tar and ammoniacal liquor and products, £79,773; and sundries, £228,174.

SOUTH METROPOLITAN GAS COMPANY'S ACCOUNTS.

[For the Half-Yearly Report, see p. 300.]

The following are the principal portions of the accounts of this Company for the six months ending the 30th of June.

The first two statements relate, as usual, to the stock and loan capital. The former sets forth that the standard rate of 4 per cent. is payable on £6,011,224 and £418,671 (Act of 1901) of stock; while the latter shows that the loan capital, the rate of interest on which is 3 per cent., amounts to £1,798,994 and £96,451 (Act of 1901). The third statement is the capital account. It stands as follows: Amount received, £5,328,820; nominal amount added by conversion (less premium), £2,996,520—total, £8,325,340. The items of expenditure are as follows:—

Capital account to Dec. 31, 1907			£5,032,611 9 2
Expenditure during half year to June 30, 1908, viz.—			
New and additional mains and services	£1,287 1 10		
New and additional meters	1,543 17 8		
New and additional stoves	1,081 7 8		
		3,912 7 2	
Total expenditure			£5,036,523 16 4
Balance			292,296 3 8
			£5,328,820 0 0
Nominal amount added by conversion, less premium			2,996,520 0 0
Total			£8,325,340 0 0

The following is the revenue account:—

Expenditure.

Manufacture of gas—			
Coal into store	£432,070 16 8		
Purification	11,538 0 9		
Salaries of Engineer and Officers at works	13,548 7 6		
Wages (carbonizing)	57,659 12 5		
Repairs and maintenance of works and plant, including labour, less £2567 18s. 2d. received for old materials	95,771 19 5		
		£610,588 16 9	
Co-partnership for twelve months to June 30, 1908	£36,426 3 6		
Less on account	13,000 0 0		
		23,426 3 6	
Distribution of gas—			
Repair, maintenance, and renewal of mains and service-pipes	£34,337 12 1		
Salaries and wages of officers, including rental clerks	18,572 7 5		
Repairing and renewals of meters, including 6315 slot meters damaged by robbery	28,728 6 8		
Repairing and renewals of stoves	30,114 17 8		
Repairing and renewals of gas-fittings	17,796 3 10		
		129,549 7 8	
Public lamps, including £16,022 5s. 9d. for labour and materials, less £14,405 11s. 5d. received for the same		1,616 14 4	
Rents, rates, and taxes—			
Rents payable	£914 16 3		
Rates and taxes	41,928 19 8		
		42,843 15 11	
Management—			
Directors' allowance	£2,787 15 0		
Salaries of Secretary, Accountant, and clerks	3,659 13 11		
Collectors { Ordinary	6,787 1 3		
Collectors { Slot meter	8,564 0 9		
Stationery and printing	2,957 15 2		
General charges	9,327 6 0		
Company's Auditors	112 10 0		
		34,196 2 1	
Parliamentary charges		32 1 7	
Bad debts		2,200 3 9	
Stolen from 6315 slot meters broken open		586 4 3	
Pensions and officers and workmen's superannuation, sick, and accident funds		6,759 7 6	
Gas Referees and Official Auditor		347 13 7	
Leasehold renewal fund		300 0 0	
Total expenditure		£852,446 10 11	
Balance carried to net revenue account		220,288 11 2	
		£1,072,735 2 1	

Receipts.

Sale of gas—			
Lady-day, at 2s. 3d. per 1000 feet	£410,201 6 8		
Midsummer, at 2s. 3d. per 1000 feet	274,778 19 2		
	£684,980 5 10		
Public lighting	17,119 10 11		
		£702,099 16 9	
Meters in use (332,946)—			
Company's meters at rent: Ordinary, 98,911; slot, 225,664	£36,699 4 7		
Company's stoves at rent: Ordinary, 76,217; slot, 184,645; fires, 22,131	29,360 8 0		
		66,059 12 7	
Residual products—			
Coke, less labour and cartage	£192,145 14 5		
Breeze, less labour and cartage	9,220 16 5		
Tar and tar products, less labour	33,465 14 1		
Sulphate of ammonia, less labour	67,834 11 6		
		302,656 16 5	
Rents receivable		1,817 11 4	
Transfer fees		91 5 0	
Total receipts		£1,072,735 2 1	

Total amount paid in wages for half year, £262,154 4s. 3d.
" " " salaries £35,560 11 9

The net revenue account shows a sum of £177,339 10s. 3d. applicable to dividend on the ordinary stock. Following this are the statements relating to the reserve, renewal, and insurance funds. They show that the balances on June 30 were as follows: Reserve fund, £186,411; renewal fund, £27,614; insurance fund, £110,061.

The statements furnishing manufacturing details are as follows:—

Statement of Coal.

In Store December 31, 1907.	Received During Half Year.	Carbonized During Half Year.	Used During Half Year.	In Store June 30, 1908.
Tons. 148,076	Tons. 541,927	Tons. 602,309	Tons. 888	Tons. 86,806

Statement of Residual Products.

Description.	In Store Dec. 31 1907.	Made During Half Year.	Used During Half Year.	Sold During Half Year.	In Store June 30, 1908.
Coke—cwts.	268,777	7,458,708	2,169,455	5,057,970	500,060
Breeze—yards	22,344	161,802	64,022	109,895	10,229
Tar—gallons	1,298,569	5,998,380	6,816,153	32,309	448,487
Ammoniacal liquor—butts	13,572	214,545	219,539	..	8,578

Statement of Gas Made, Sold, &c.

Quantity Made.	Quantity Sold.		Total Quantity Accounted for.	Number of Public Lamps.
	Public Lights (estimated).	Private Lights (per Meter).		
Thousands. 6,423,386	Thousands. 162,977	Thousands. 6,132,974	Thousands. 6,379,462	23,538 incandes't 21 flat flame

The remaining statement is the balance-sheet, which gives the value of the stores in hand at the close of the half year as follows: Coal, £62,179; coke and breeze, £16,023; tar, sulphate, and ammoniacal liquor, £45,465; and sundries, £290,272. The figures this time last year were: Coal, £51,157; coke and breeze, £9097; tar, sulphate, and ammoniacal liquor, £41,635; and sundries, £286,433. A sum of £36,359, workmen's bonuses and savings, has been deposited with the Company; and the total of the officers' superannuation and guarantee funds is £47,162. The figures last year were £61,021 and £40,426. The item, "Monazite sand suspense account," no longer appears.

SOUTH SUBURBAN GAS COMPANY.

Half-Yearly Report and Accounts.

The following is the report of the Directors for the six months ending the 30th of June, which, with the accounts, will be presented at the half-yearly general meeting on Friday.

The Directors have the pleasure to announce a reduction in the price of gas to 2s. 6d. per 1000 cubic feet from Midsummer last, which will reduce the bills of the consumers by £5500 a year.

There is a slight reduction in the price of coal; but it has not fallen at all in proportion to the decline of trade—particularly the iron trade—throughout the country. The general depression is doubtless to a considerable extent due to the high price of coal, which will in all probability be permanently dearer if the Coal Mines (Eight Hours) Bill is passed into law.

The coal bill for the half year is £56,318; being £6716 more than in the corresponding period; while the receipts for coke are £24,104, or only £1926 more than in the half year to June, 1907. The receipts for tar and ammonia are £638 better; and the gas-rental, owing to the increased price, is £4274 in excess of last year. Some economies have been effected in manufacture, with the result that the balance to be carried to the net revenue account is sufficient to enable the Directors to recommend that the full dividend of £5 6s. 8d. per cent. authorized under the sliding-scale be paid, and to increase the amount to be carried forward to £8253.

The Company's co-partnership system—begun from Midsummer, 1893, the first bonus being paid in 1894—grows better and more effective and satisfactory as it grows older. The employees, from the highest to the lowest, who respond in the right spirit, are admitted to the partnership. We pay the current rate of salaries and wages, governed by the law of supply and demand; and, in addition, a sliding-scale bonus is given to the employees. As the shareholders are allowed by Parliament an increase of dividend for every 1d. reduction in the price of gas—thus making them and the consumers partners—so are the employees given a certain percentage on their salaries and wages for every reduction of 1d. per 1000 cubic feet of gas. This brings them into the partnership, and thus identifies the interests of consumers, shareholders, and employees; making it to the direct interest of the last two to do their best for their customers. The employees' bonus for the last twelve months is at the rate of 5 per cent., and amounts to £2407, of which half is, by the rules, invested in the Company's ordinary stock; and the Directors are glad to state that the other half is voluntarily also so invested. The employees—about 550 in number—have now over £30,000 in the Company, and are therefore owners of a large amount of property, increasing year by year. Thrift is thereby encouraged, their present position is improved, they have hope for the future, and character is developed. The Archbishop of Canterbury, in April last, said "he believed that nothing of the human sort could be a stronger agency in the formation of character than thrift, which made men and women fitter citizens." The Directors have found, and are pleased to record, that co-partnership, in benefiting the employees and making them better men, equally benefits the Company by the improved service rendered; and they have also the satisfaction to report that the completion of the co-partnership by the inclusion of the employees in the responsibility of management, by the election of two workmen as Directors, is perhaps the most encouraging element of the system. The Company many years ago established sick and burial and superannuation funds for their employees, with joint contributions, thereby forestalling and rendering unnecessary State pensions. A mutual accident fund is also in existence, which provides certain compensation for all accidents, and also enlists the active co-operation of all employees in their prevention.

As a result of the last meeting, a vacancy arose on the Board. The Directors wished to acknowledge the valuable services rendered during forty years by their late colleague Mr. C. Lea Wilson, and expressed their regret that, owing to the infirmities of his great age, he could not continue to attend the Board. To fill the vacancy, they elected Mr. John Boraston, J.P., of Beckenham, who they had every reason to believe would be a good and useful Director; and they have not been disappointed.

The accounts accompanying the report show that nothing was spent for capital purposes in the first half of the year. The total capital expenditure on the 30th of June consequently amounted to £806,636, or £24,727 less than the receipts, including the premium capital, as on Dec. 31 last. The net revenue from the sale of gas was £88,045; the rental of meters and stoves produced £6228; the sale of residuals, £32 915; and a small item of rents brought up the total receipts to £127,234. The following were the principal items of expenditure: Manufacture of gas (including £56,319 for coals and £11,803 for maintenance of works and plant), £76,064; distribution, £12,968; management, £4910 – rents, rates, and taxes (£4529), and miscellaneous items bringing up the total to £102,182. Among these items is a sum of £907 paid to employees under the co-partnership scheme; making £2407 for the year to June 30. The balance carried to the net revenue account is £25,052; and the amount applicable for dividend is £25,886. The statements relating to the working show that 67,655 tons of coal were carbonized in the half year. The quantity of gas made was

728,463,000 cubic feet, of which 686,075,000 cubic feet were sold and 695,584,000 cubic feet were accounted for. The residuals were: Coke, 811,860 cwt., of which 202,333 cwt. (estimated) was used in manufacture; breeze, 15,785 yards (9727 yards used); tar, 682,278 gallons; ammoniacal liquor, 16,042 butts—the make of sulphate of ammonia being 705 tons.

BRENTFORD GAS COMPANY.

The Half-Yearly Report and Accounts.

In the report which the Directors of this Company will present at the half-yearly general meeting on Friday, they announce an increase of 7·61 per cent. in the sale of gas in the six months ending the 30th of June, compared with the corresponding period of 1907; while the receipts for coke again added materially to the revenue. The number of consumers, both ordinary and automatic, also continued to increase—being 611 and 5848 respectively over the corresponding period of 1907; and the Directors report that "the business of the Company generally is in a very satisfactory condition." They add that the decision against the Company, at the Acton Petty Sessions, for deficiency of illuminating power, was carried to the High Court, where it was quashed, as recorded in the "JOURNAL" for June 9 (p. 646).

The accounts accompanying the report show that the revenue from the sale of gas amounted to £179,944; from meter and stove rents, to £18,597; and from the sale of residual products, to £43,191—rents and transfer fees making up a total of £241,771, compared with £218,580 in the corresponding period of 1907. On the other hand, the manufacture of gas cost £132,468; distribution, £45,955; and management, £7033—the total expenditure being £200,672, against £173,379. The balance carried to the profit and loss account is £41,099, compared with £45,201 this time last year. The amount available for distribution is £100,098; and the Directors recommend the declaration of dividends at the rates of 5, 12½, and 9½ per cent. per annum on the preference, consolidated, and new stocks respectively. The working statements show that 93,225 tons of Newcastle coal and 1,305,487 gallons of oil were used in the production of 1,421,856,000 cubic feet of gas, of which 1,300,862,000 cubic feet were sold and 1,317,262,000 cubic feet accounted for. The estimated production of residual products was: Coke, 58,286 tons; breeze, 7271 tons; tar, 1,094,087 gallons; ammoniacal liquor, 27,411 butts.

GAS-FIRES AND SMOKE PREVENTION.

At the Meeting of the British Medical Association in Sheffield last week, Dr. Des Vœux read a paper, in the section of Public Health and Forensic Medicine, on the subject of smoke abatement, with which his name is closely associated.

The author commenced with a description of the formation of smoke-fog on a summer day, and then traced the source of fog. So far as London was concerned, he said the kitchen chimney was the greatest offender. Whether the weather was hot or cold, people required food; and they did not stop to think how far cooking it might be a nuisance to their neighbours. Gas, however, was now replacing coal for cooking, and the author firmly believed that twenty years hence cooking by coal-fires would be obsolete. Gas cooking saved labour, created no dirt, and food prepared by its agency was as sweet and digestible as when cooked over coal. Electrical cooking apparatus was also coming into greater use. He had no personal knowledge of it, but saw no reason why it should not be practicable.

Concerning the use of gas for bed-rooms and sitting-rooms, the author described how easily gas-fires could be ignited, and how quickly they gave off their full heat. Many people thought gas-stoves "nasty, dirty, smelling things." This was largely due to bad fitting; and he was glad to say that men were being specially educated now for the purpose of putting in gas-fires, and in a few years little would be heard of the complaint. One advantage of gas-fires was the small quantity of air that was drawn through the fire and carried up the chimney. Coal-fires took away much more air, and so created more draught.

After a few remarks in praise of Coalite, Dr. Des Vœux went on to deal with the question of factory smoke. Sheffield, he said—famous all the world over for its manufactures—was once notorious for its smokiness. Now he understood this reproach had been removed, because sanitary administration had determined that no avoidable smoke should be visible from factory chimneys. He had only been in Sheffield a few hours, but he agreed that the general report as to an improvement must be true. At the same time, there was still room for further progress. He had seen a few chimneys of which the smoke inspector would do well to take notice. Where the Smoke Abatement Act of 1875 had been put into force, smoke from factory chimneys had been largely done away with. Sheffield, for instance, which had taken advantage of the Act, now claimed to have more sunshine than any other industrial town in the country. If manufacturers had to live in the districts in which their works were located, he thought a speedy improvement would be effected.

In conclusion, Dr. Des Vœux noted that members of the medical profession, having access to almost every house in the country, might do a great deal for the slums and the toilers who spent their lives in narrow streets if they could secure for such localities pure rays of sunshine, which at present were diminished in intensity, or for many weeks blotted out, by an overhanging pall of smoke, by banishing that which science had shown to be as unnecessary as it was costly.

In the Chancery Division of the High Court of Justice last Tuesday, Mr. Justice Swinfen Eady made an order for the compulsory winding up of Meldrum Bros., Limited.

THE PRINCIPLE OF CO-PARTNERSHIP.

South Metropolitan and South Suburban Companies' Scheme.

The Co-Partnership Schemes of the South Metropolitan and South Suburban Gas Companies, which in practice have proved—as the originator, Sir George Livesey, the veteran Chairman of both Companies, always felt confident they would—of mutual advantage to employers and employed, are nearing their majority; for this year the nineteenth annual distribution has taken place. It has been the custom for the Directors to celebrate this happy event in the lives of the men and officers of the two Companies by a dinner at the Crystal Palace—a kindly thought which it is needless to say is much appreciated by the co-partners and their wives, who are also invited. Last Thursday was the date fixed for this year's function, which, as usual, proved a very pleasurable one to all concerned. Seated at eleven long tables in Lyons's Restaurant, the guests, who probably numbered over 400, first enjoyed a good dinner, and then listened to some excellent speeches on the subject which all connected with the Companies have so much at heart. Sir George Livesey, of course, presided; and the other Directors present were: Mr. John Mews and Mr. Frank Bush, and Mr. Henry Austin, Mr. C. T. Drumgold, and Mr. H. T. Manley (the last three being Workmen Directors) of the South Metropolitan Company; and Mr. Charles Hunt and Mr. John Boraston, and Mr. W. G. Waller and Mr. R. Wyllie (the last two being Workmen Directors) of the South Suburban Company. Among the officials were Mr. Charles Carpenter, Chief Engineer, and Mr. F. M'Leod, Secretary, of the South Metropolitan Company; and Mr. S. Y. Shoubridge, Engineer, and Mr. Charles M. Ohren, Secretary, of the South Suburban Company. At the conclusion of the dinner,

Sir George Livesey, on rising, referred to the gathering that day, and said it was the only way in which the Directors could show their personal interest in the employees of the two Companies; and unfortunately several members of the Boards were unable to be present. Mr. Ewart, of the South Metropolitan Company, had gone for his holiday; Mr. Morton, the Deputy-Chairman, much to his regret, was not able to come; and one or two others were in the same fix. As far as the South Suburban Company were concerned, Sir Fortescue Flannery, who had been present at similar previous gatherings, wrote saying he was compelled to attend at the Admiralty Court, and so could not meet his friends and fellow-workers of the South Metropolitan and South Suburban Companies; but if he had met them again on this occasion, he should once more have testified to his increasing faith in co-partnership as the national remedy for unequal distribution of wealth and for giving every man his deserts, while helping to raise every man's self-respect and develop his personal character. Mr. Light, another of the Directors, was unable to be at the dinner owing to a business engagement elsewhere; but he hoped to come down later. Mr. Morton, who was, as he had already mentioned, unavoidably absent was, of course, Deputy-Chairman of both Companies. Sir Fortescue Flannery's remark about the distribution of wealth, gave him (Sir George) a text, for it fell in with what he had been thinking about. A few days since, it was said in Parliament, by a member of the House of Commons, speaking on the Old Age Pensions Bill, "What we want to do is to make the rich poorer and the poor richer." This was not altogether a nice sentiment; and Lord Rosebery took it up in the House of Lords. Speaking on the same subject, he said: "It is proposed to make the rich poorer and the poor richer. It is very simple to make the rich poorer; but it does not follow that thereby you will make the poor richer." Coming from a man of Lord Rosebery's experience, these words were worth consideration. What these Socialists—it was a prominent Socialist, Mr. Snowdon, who made the statement to which Lord Rosebery referred—were aiming at was to take from the rich and give to the poor. One idea was that all a man's income beyond a certain point was to be taken from him by means of an income tax. This tax was to range between 1s. and 5s. in the pound on moderate incomes; and after a certain income was reached, 20s. in the pound was to be charged. He (Sir George) mentioned this to a man in London who conducted his work on thoroughly honest principles, and employed a large number of people. This man said that if such a suggestion were adopted, he should stop a number of his businesses, so as not to earn more than the figure at which they would take 20s. in the pound. This was not the way to make the poor richer. This brought him back to the principle on which these two Companies were working—that of co-partnership. Sir Fortescue Flannery said it was the national remedy for the unequal distribution of wealth; and he (Sir George) agreed with this. While it had made the poor richer, it had not made the rich poorer. In fact, he claimed that it had been a benefit alike to the capitalist and the workman—a benefit all round. Now as to property. The amount that had been saved by some 6000 men in the two Companies was getting on for half-a-million of money. It was invested in the business of the two Companies; and by means of this money, and money subscribed by other people, the Companies had been able to extend their business and give employment to a great many more people. For instance, the South Metropolitan Company twenty years ago employed about 3000 men; whereas now they employed some 6000. The money the employees had saved had enabled the Company to extend its business and thus to increase employment; and, after all, this, he thought, was one of the best ways to use surplus money. And then the money the employees had saved had enabled the Building Society connected with the two Companies to live. If it had not been for this money, the Society would have come to grief, because they would not have had the money to advance to people who wanted to buy houses. The Trustees of the two Companies, out of the withdrawable amount, had advanced to the Building Society about £25,000; and this sum had been distributed in advances to the employees of both Companies for the purchase of their houses. Therefore he thought it was perfectly right and safe to say that by co-partnership they were effecting what the Socialists said they wanted to do. He agreed with them there; but on no other point. He was in agreement with their object of creating a better distribution of wealth; but there was an honest way of doing it, and he thought their Companies might claim that theirs was the honest way.

The co-partnership principle was the sound and proper principle on which business ought to be conducted; and it had more than a monetary advantage. In the old days, employers and employed worked together, and knew each other, and were personal friends with mutual interest and sympathy; but now it was impossible for employers to know all their employees. How then could they create a tie and bond? Mazzini had said that the ultimate position of a labourer must be that of partner; and by their scheme they were trying to make employers and employed alike partners in the business—partners in prosperity and in losses. They were sharing the losses now, because they had a less bonus than a year ago. They were also sharers of responsibility; and this was most important. There were on the Boards of both Companies representatives elected by the workmen and employee shareholders. Mr. Austin, a South Metropolitan Director, was now the oldest of these representatives, as Mr. Butcher had retired. Then there was Mr. Drumgold representing the official staff; and Mr. Manley had been recently elected in place of Mr. Butcher. In the South Suburban Company, they had Mr. Wyllie and Mr. Waller, who represented the workmen. They could also have a clerk elected; but the staff had not thought it necessary to appoint him. Well, in this way, the employees shared in the responsibility of the management. Everything was open to all the Directors. There was not the slightest difference in the Board-room. They were all there on an equality, perfectly free to express their opinions and take part in the business of the Company. It seemed to him that this gave them even greater advantages than existed in the old times. If they came to carry out this principle of co-partnership, too, it meant more. It was the principle of brotherhood and friendship; but he went further. It seemed to him it was the application of the highest principle of all. There was one principle laid down for the conduct of man in his dealings with his fellows that was applicable to all circumstances, to all ages, and to all periods; and this was the principle laid down by their Lord Jesus Christ—"Therefore all things whatsoever ye would that men should do to you, do ye even so to them." It had been said that this would not do in business—that each man must try to do the best he could for himself. Well, they had tried to do what was right, and to act upon the principle of doing as they would be done by; and they had their reward. He was sure there was no business in this country in which the relationship of employers and employed was on a more satisfactory and friendly and safe footing than was the case with the two Companies; and he believed this was due to them all striving to do to others as they would be done by. He was glad to welcome the ladies there that day, as it was the only opportunity they had of seeing them. Among the men present there were many who had become owners of property, who without the help of their wives, he was sure, would not have been in such a fortunate position. He was speaking for the whole of the Directors when he said that these dinners were a little personal affair of their own; and they arranged them with the idea of showing their goodwill and friendliness towards the employees. Before sitting down he asked his old friend Canon Ransford to say a few words.

Acceding to this request, Canon Ransford remarked that the principle of co-partnership, as solving the great difficulties existing between Capital and Labour, had long ago won his admiration and adhesion. During the session of the Pan-Anglican Congress, he read carefully what was said on these questions there; and, honestly speaking, the only words that seemed to him worth listening to were those of their Chairman, Sir George Livesey, that this system afforded the best possible solution of the difficulty. It brought employers and employed together to one common end. They were not always so associated. He had never forgotten the last visit he paid with Sir George to the South Metropolitan works. He noticed the kind of work that was being done by the men in every department, and the excellent spirit evinced by all the workers towards their employers. He had never seen anything that commended itself to his mind so much as did the scheme that was in operation in these two Companies. He wished Sir George and the Companies God-speed in their splendid and blessed work.

The last-appointed Director of the South Suburban Gas Company, Mr. John Boraston, said he was proud to assist in his humble way in the furtherance of the co-partnership principle. A great writer had said that there were two ways by which men might get to know each other—one was by working together, and the other was by sorrowing together. Without being exhaustive, this was true as far as it went; and working together was without a doubt the surest and most direct avenue to mutual knowledge and mutual respect. He agreed with what Sir George had said, that perhaps the most important feature of the co-partnership scheme as practised by the two Companies was that it provided for the election of Workmen Directors. The Board was strengthened by the co-operation of men who possessed the perfect confidence of their fellows. It was the natural development and outcome of their system that this community of responsibility should accompany community of interest. He could not find words to express his appreciation of the services rendered by his workmen colleagues on the South Suburban Board. In all matters relating to internal working their knowledge was, of course, peculiarly valuable; and in regard to other questions they displayed general ability and a breadth of view which was most creditable, though no more than one should expect from the best type of British workmen. They were men with whom it was a pleasure to work, and with whom it was a just source of pride to be associated. One striking feature of the co-partnership system was the direct encouragement which it gave to thrift. The nation which most encouraged thrift, would be the most successful. He believed, now that it had been firmly established, co-partnership would go on increasing in strength and adding to the number of its adherents.

Several short speeches followed from employees of the two Companies. Mr. Charles Froude proposed a hearty vote of thanks to the Chairman and Directors for their hospitality, and also for introducing one of the grandest systems ever known in the country. Mr. C. Fox seconded the proposal; and Mr. John Mason, in supporting it, remarked that he had once been advised, if he had money to invest, to put it into gas and water shares. Well, he had no water shares; but thanks to Sir George Livesey and the other Directors, he had got some gas shares.

The proposition having been carried by acclamation, Sir George Livesey said he would call on the youngest Director of the South Metropolitan Company to respond—that was, Mr. Frank Bush. On rising, Mr. Bush (the former Secretary, and now a Director, of the South Metropolitan Company) was accorded a very cordial reception, for which he heartily thanked those present. Proceeding, he remarked that they must all admire the indomitable pluck and energy of Sir George Livesey, who, by his wonderful perseverance, had brought the scheme to the position it now occupied. They all hoped that he might have many years of health and happiness to continue his good work. This was the nineteenth bonus distribution; and it had occurred to him that it would be a good opportunity to look back and see what had been accomplished in this period. This year the distribution amounted to nearly £37,000; while since the inauguration of the system, no less than £428,000 had been distributed. The largest bonus was in 1907, when it was £45,590; and the lowest in 1890, when it was £6037. What had been done with this large sum of money? He thought they had a very good record. At Christmas last, the value of the stock and money in the hands of the Company and Building Society belonging to the employees amounted to nearly £348,000; so he thought it could be said the object of the scheme had been attained—namely, "To induce the employees of the Company to take a real interest in their work, by giving them a new motive for endeavouring to promote the prosperity of the Company; and, of equal importance, to give them an opportunity to improve their position in life by saving their annual bonus and becoming owners of property in the stock of the Company." They certainly had become owners of property in the stock in the Company. He remembered a few years ago there was just a touch of disappointment, because the system had not been more readily adopted elsewhere. Happily in the past year several other companies had agreed to adopt co-partnership; and he believed several others were thinking of doing so. In the discussion which took place at the recent meeting of the Institution of Gas Engineers on the paper read by Sir George, Mr. Meiklejohn, the Engineer and Manager of the Rugby Gas Company, who were adopting the scheme, said he regarded the system as a righteous one; and he (Mr. Bush) thought he was correct in doing so, for it seemed to be just and equitable that the employees who materially assisted in building up the prosperity of a business should share in that prosperity. Not long ago in the House of Commons, in a discussion on Capital and Labour, a speaker said that the ultimate solution was for the workers themselves to accumulate capital, and become capitalists and wage-earners at the same time. This was exactly what they were doing. Again, Sir Benjamin C. Browne, in the course of one of his articles on Labour Problems in "The Times" said: "Nothing would be so great a gain, both to the trade of the country and to the working classes themselves, as for the workmen to make serious efforts to invest capital in the companies for which they work. It is not only the profits they would make, but the experience they would gain; and if many were shareholders some would be Directors, and the two classes would be brought nearer and nearer both by community of interest and by experience. Whatever makes Capital and Labour pull together, as indeed it is their true interest to do, must tell most forcibly and favourably on the trade of the country."

A few remarks were then made by Mr. R. Wyllie, a Workman Director of the South Suburban Company, who said he knew full well that Sir George and his fellow Directors were doing their very best for the co-partnership scheme and for the workmen. He felt sure that the employees would prove in the future, as they had done in the past, that giving them a share in the management was of mutual benefit.

Sir George Livesey next called upon Mr. F. M'Leod, the new Secretary of the South Metropolitan Company; remarking that Mr. M'Leod had been in the employ of the Company for thirty years, and had by his ability risen from the bottom of the ladder to the position he now occupied.

Mr. M'Leod said there was a point in Mr. Bush's speech to which he would refer—the statement that the sum belonging to the employees was nearly £400,000. It was difficult to realize what such a sum meant; but he found it represented the capital employed in the Gas Companies of three of the largest towns in Essex—Chelmsford, Colchester, and Southend. This showed that they were sufficiently wealthy, if it were desirable, to transfer their money and light the three towns named, or three towns in Kent—Ramsgate, Margate, and Broadstairs. He had no fear for the success of co-partnership, if they did their duty towards it; but it depended upon their own efforts. In the six months January to June there had been in the United Kingdom strikes and lock-outs involving a loss in wages of over £1,000,000; and but for the co-partnership scheme under which their two Companies worked, there was no reason why some part of this loss should not have fallen upon them.

Mr. H. T. Manley, a Workman Director of the South Metropolitan Company, pointed out that co-partnership had done even more for the men in the way of increasing their self-respect than it had done for them financially.

Mr. Shoubridge and Mr. Carpenter were then called upon to make a few remarks. Mr. Shoubridge said that as the co-partnership scheme grew older with the South Suburban Company, it grew stronger and more useful. At no period in the history of the Company with which he was acquainted had there been greater evidence of a desire on the part of all classes of workmen to do their utmost for the good of the undertaking. This was abundantly proved by the result of the past year's working, which, in spite of dearer coal and other circumstances, exceeded that of any previous year. On behalf of the South Suburban employees, he had to thank the Board for the handsome bonus of £2420 just received, which made the total amount nearly £31,000, or about £56 per man. Not a single penny of the bonus this year had been withdrawn.

Mr. Carpenter referred to Mr. Manley's remark about the increased self-respect of the men, and said when he looked back nineteen years he himself saw a great difference in the state of affairs existing then and now. Now he saw nothing but friends around him; whereas in the old days, their real friends were perhaps one or two of the foremen. This was a great change; and it had been brought about by their Chairman. In spite of what croakers might say, he was sure, at any rate in regard to their own industry, that while there were retorts to

make gas and pipes to distribute it, the co-partnership system would last.

Mr. W. Luther, of the South Suburban Company, said he wished to thank the Directors for their hospitality and for the handsome bonus, both of which were appreciated by all; and Sir George Livesey, in bidding the party adjourn to the Palace grounds, remarked that they had that day had evidence of the continuance of co-partnership. On behalf of the officers who worked the scheme he must say a word. There were Mr. Sims and the various branch officers in the South Metropolitan Company, and Mr. Jones and others in the South Suburban Company; and the success of the scheme was largely owing to them.

After a pleasant afternoon in the beautiful grounds, the party assembled again in the restaurant for tea.

PUBLIC LIGHTING OF THE CITY OF LONDON.

We have received from the City Engineer (Mr. Frank Sumner, M.Inst.C.E.) his report on the works executed by the Public Health Department of the Corporation of London during the year ending Dec. 31, 1907. It furnishes the following particulars in regard to the public lighting.

The number of incandescent gas-lamps (including experimental lamps) paid for by the Corporation at the end of last year was 2765; being a decrease of 39 compared with 1906, accounted for by the removal of a number of lamps in the side streets adjacent to the thoroughfares lighted by experimental electric lamps. For the first half of the year, the price charged for gas was 2s. 2d. per 1000 cubic feet, and there was paid a fixed sum of 6s. per lamp per annum for the incandescent mantles for the ordinary lamps. In the second half of the year, the price was raised to 2s. 5d. The prices paid for the various kinds of lights are fully set out in two tables. There were in use 2678 square and 87 circular lanterns. The consumption of gas by ordinary incandescent burners ranged from 3 up to 21·75 cubic feet per hour; by far the larger umber of them (1972) consuming 4·25 cubic feet. In the case of the high-pressure burners, 10 and 20 cubic feet were the quantities generally consumed; but one burner used 100 cubic feet and six used 60 cubic feet each per hour. There were 30 special burners in operation last year. In July, two double-burner incandescent gas-lamps were fixed in Fore Street, to better light the entrance to the public way through Cripplegate Churchyard, in lieu of one electric lamp removed. In January, a double-burner high-pressure lamp was fixed on a "rest" in Lombard Street, in place of an electric arc lamp; and one of the latter lamps at the corner of Lombard Street and St. Swithin's Lane was removed, and an ordinary single-burner incandescent lamp was substituted.

The number of defective gas-lights observed and reported upon during the year was 2278—viz., 1843 ordinary and 435 high-pressure lamps. The details of lighting defects in the ordinary incandescent lamps were as follows: Feeble lights, 1485; lights went out, 12; not alight during the night, 14—total, 1511. In addition, 332 defects in the lanterns and burners were reported to the Gaslight and Coke Company and rectified. The readings of the meters attached to the public lamps in various parts of the City showed that the full contract quantity of gas was given at these lamps. Mr. Sumner expresses the opinion that this is the case generally, and that the regulators of the lamps are kept in proper order. The lamps were lighted whenever fog or unusual darkness occurred. This happened on 33 days last year, and entailed an additional cost of £219 2s.

The lighting of most of the main thoroughfares of the City by arc lamps was continued. The number of lamps of the older type in use at the end of the year, at a cost of £26 each, was 400. This was a decrease of 39 compared with 1906, mainly accounted for by the substitution of the new and cheaper flame arcs, fitted up experimentally by the two Electric Lighting Companies, in November. These lamps were lighted on nine days when fog or unusual darkness occurred, at a total additional cost of £43 12s. 11d. The number of defective electric lamps observed during the year was 99. For these the City of London Electric Lighting Company were fined; the amount deducted from their account being £24 4s. 11d. One electric arc lamp was removed from the east side of Adelaide Place; the light afforded by the adjacent high-pressure gas-lamp being considered sufficient to light this part of the thoroughfare. Four other arc lamps were removed, and gas-lamps substituted for them. The total number of public electric lamps of all kinds in operation on Dec. 31 last was 451, against 449 on the corresponding date in 1906. The prices charged were £12 10s., £17 10s., and £26 per lamp per annum according to the kind of lamp.

Referring to the experimental electric lighting sanctioned by the Corporation in July, Mr. Sumner says the Charing Cross and Strand Electricity Supply Company proceeded with the lighting of their portion (Cannon Street) by erecting eleven magazine "flame" arc lamps—five of the "Oliver" type and six of the "Gilbert" make—centrally hung; being suspended over the roadway by wires attached to the buildings on either side. These wires were subjected to a very severe test, by dead-weight and a drop-weight, considerably heavier than the lamp. The lighting of the lamps was started on the 21st of November.* The City of London Electric Lighting Company also proceeded to carry out their experiment by substituting 21 "Oliver" flame arcs for a similar number of the original arcs, adapting the existing columns in Holborn, on Holborn Viaduct, and in part of the Old Bailey, while in Farringdon Street 18 enclosed arc lamps of the "Reason" type were fitted up on special short columns in lieu of the 12 original arc lamps and columns in that thoroughfare. This installation was completed by the 20th of November. The maintenance cost of the "Oliver" flame arcs in the Holborn area is £17 10s. each per annum; being equivalent to the Charing Cross Company's charge in Cannon Street. The cost of the enclosed arcs in Farringdon Street is £12 10s. each per annum.

* A report on the street lighting of the City, by Mr. A. A. Voysey, the Electrical Engineer, will be found in the "JOURNAL" for the 9th of June (p. 640).—ED. J.G.L.

GAS-METER TESTING IN EDINBURGH.

We have received from the Chief Inspector of Gas-Meters in Edinburgh (Mr. William Gordon) his report on the working of the Gas-Meter Testing Department of the Corporation for the year ending the 15th of May last, which has lately been presented to the Lord Provost and Magistrates of the city.

Mr. Gordon states that in October last the central office of the department was removed to the City Chambers, where the model gasholders are now deposited. The new suite of rooms is quite modern, and well adapted for the purpose of testing meters. In compliance with instructions received from the Town Council, there has recently been fitted up a 60-inch Letheby-Bunsen standard photometer, with the view of testing the illuminating power of Edinburgh gas, as well as for research work. The instrument will be used for determining the illuminating efficiency of the burners supplied to the Corporation for their different departments where gas is consumed. The photometer and appurtenances are officially stamped by the Board of Trade, and meet all the requirements of the Gas Referees. There has also been installed a recording voltmeter, for the purpose of registering the pressure of electricity as supplied to the City Chambers and the vicinity.

The number of meters tested during the period covered by the report amounted to 86,025—16,404 wet and 69,621 dry; and fees to the amount of £2352 were collected. The total number of meters tested by the department since its institution in 1861, up to and including the 15th of May last, is 2,253,256 (999,794 wet and 1,253,462 dry); the fees received being £66,464. Of the total number of dry meters tested, 744, or 1·07 per cent., were rejected as incorrect; of the wet meters, 26, or 0·16 per cent.

An appendix to the report furnishes the following particulars as to the number of automatic and ordinary gas-meters tested and examined during the year:—

	Number.		Percentage.
Automatic meters, new	35,167	..	40·88
,, ,, repaired	7,244	..	8·42
Ordinary meters, new	35,242	..	40·96
,, ,, repaired	7,988	..	9·29
,, ,, tested "for certificate"	384	..	0·45
Total	86,025	..	100.00

Another appendix is a statement showing the receipts and expenditure during the year. The former amounted to £2353 19s., and the latter to £1386; leaving a balance of £967 19s.

GAS v. ELECTRICITY FOR ASYLUM LIGHTING.

At a Meeting of the Cambridge County Council last Thursday, Mr. Webber moved—"That the Finance Committee be empowered to consent to an expenditure by the Visitors of the Fulbourn Lunatic Asylum of a sum of £2100, of which the county's share is £897 8s. 1d., in lighting the Asylum with electricity." He said the Council would remember that some time ago a scheme was sent up to the three constituent bodies which involved a capital outlay of something like £7000, and that the Council and the Borough Council threw out the scheme. The Visitors considered, in view of their previous scheme having been rejected, it would be desirable to call in some gentleman who was conversant with all these matters, and Mr. Graham Harris was appointed to advise them. He submitted six schemes, but strongly recommended the last one, which was an offer of the Cambridge Electric Supply Company to supply electricity for lighting purposes. Mr. Webber proceeded to give an outline of the scheme, which he said would involve a capital expenditure of £2100, while the total annual cost would be £505. The annual cost for all charges would be less than under the present system; there would also be a great saving in the labour account; and the Visitors would not have to consider any amount for depreciation—an important item in lighting schemes.

The motion having been seconded, Mr. Harding-Newman said that, in examining the scheme roughly, he found that a very grave error had been made; 12,000 Board of Trade units having been taken as equal to 3 million cubic feet of gas. Mr. Webber told them that 12,000 units were sufficient to light the Asylum, and the illuminating power given by them was 9·6 million—roughly 10 million candles. But 3 million cubic feet of gas produced 60 million candle power—six times as much. He would strike off 25 per cent. for undue keenness on the part of gas engineers; but he had taken the electrical figures from Mr. Graham Harris's report. Thus they might reduce the illuminating power of the gas to 45 million candles, compared with the 10 million candle power of the electricity. If they added to the electrical units the same amount of power as the gas, they must put £224 5s. on as extra cost; and they would then get a total cost of upwards of £700. They had again to consider that the boilers were reported to be bad. He could not see why, if they had gas, they should not put in gas-engines, which they knew were more economical than steam. As they had had so short a time to consider the report, he moved, as an amendment, that the consent of the Council be refused.

Mr. Adie, in seconding the amendment, stated that the members had scarcely been given time to digest the report. It seemed to him to be very injudicious to give up the idea of utilizing the gas supply they had, unless more favourable figures were given than those in the report. Mr. E. O. Fordham said he hoped that the Council would give a very definite vote in favour of the proposal of the Visitors. He acknowledged that he had only had time to read the report rather hurriedly; but it struck him that it contained a very satisfactory solution of a matter which had caused much anxiety.

Mr. Webber said his answer to the amendment was that Mr. Graham Harris had approved and strongly recommended that the offer of the Electric Light Company be accepted by the three constituent bodies. He thought when they were advised by a man of Mr. Graham Harris's abilities, it was hardly for a layman to go behind that advice. He

personally asked Mr. Graham Harris whether 12,000 units was equivalent in lighting power to 3 million cubic feet of gas; and he replied, "Yes, more." They must remember that 12,000 units of electricity were worth very much more to-day for lighting purposes than they were a year ago, by reason of the introduction of the new filament lamp, which saved about one-third of the electrical energy.

In the result, the original motion was carried.

DEVONPORT WATER SUPPLY.

The Proposed New Reservoir.

At a Meeting of the Devonport Town Council last Thursday, Alderman E. Blackall, the Chairman of the Water Committee, moved the approval of the minutes of the Committee, which recommended the adoption of the plans and estimates of Mr. Lillicrap, the Water Engineer, for the construction of a new storage reservoir at Crownhill. The capacity of the new reservoir is to be 20 million gallons; and the estimated cost of the works is £31,000. Mr. Blackall reminded the Council that the old Water Company went to Parliament for powers to enlarge and improve the undertaking, and that as the result of the Corporation's opposition the concern was transferred to them. The necessity for improving the works remained, and their own officials would do it at a saving of £10,000. A scheme had been suggested for the construction of a larger storage reservoir, at a cost of £150,000; but this it was quite out of their power to undertake.

Alderman Hornbrook seconded the motion, though he regarded the building of the reservoir as a waste of money. Two sets of pipes, for Plymouth and Devonport, were running in close proximity; and they were to have two reservoirs, while Plymouth had one which was ample for all the needs of the two boroughs. The responsibility for the expenditure was with Plymouth, who slighted their overtures.

Alderman Waycott said he had a strong conviction that the most economical process to adopt in connection with the general supply of water to the district would be to run the water from their gathering ground into the Plymouth storage reservoir, and for Devonport to have a separate pipe-line thence to their own service reservoirs. It was most unreasonable that such an arrangement could not be entered into with Plymouth. Referring to this remark, Alderman Littleton said he wondered whether the Council really thought Plymouth would allow them to run their waste water into the reservoir at Burrator on equal terms. It had cost Plymouth at least £150,000 to construct their reservoir; and it was unreasonable to think that Devonport could come in on equal terms, when they could construct one for themselves for £31,000. To this, Alderman Waycott replied that he had not suggested that they should go in on equal terms. Alderman Littleton said he considered it would be more economical to build a reservoir for themselves than submit to the terms which Plymouth might dictate.

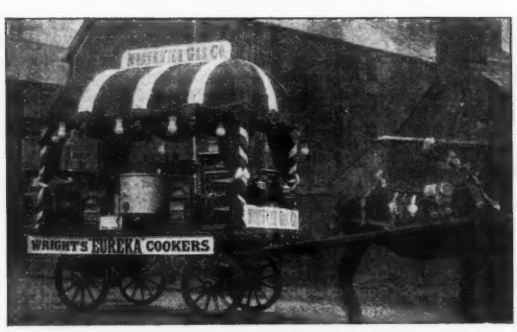
The report of the Committee was adopted.

NOTES FROM SCOTLAND.

From Our Own Correspondent. *Saturday.*

We were able to give last week the decision in the parliamentary inquiry into the Provisional Order of the Edinburgh and Leith Gas Commissioners, and very little requires to be added to what has already appeared, except to emphasize the hollowness of the opposition, as exemplified by one incident—the promptitude with which the Commissioners gave their decision. They only spent a few minutes in deliberation. It is impossible to say what expectations were entertained by those who caused all the trouble; but after the decision was given they quite naturally looked crestfallen. The Town Clerk endeavoured to cheer them in their despondency by the reflection that the decision was not so favourable to the Gas Commissioners as would have been the offer which he made to them. That offer was the absurd proposal that the gas should be supplied of 16-candle power at Granton, and of 14-candle power at the City Chambers. To most people the feeling will be that the Gas Commissioners have distinctly scored in getting rid of the obligation to supply 16-candle gas at Granton, and that the opposition were defeated on every point. It is remarkable how little interest in the proceedings was taken by the community. The general opinion is that the Gas Commissioners have done exceedingly well in erecting the Granton Gas-Works at great cost, and yet, notwithstanding, being able to reduce the price of gas. This feeling engenders confidence in anything which the advisers of the Commission may propose; and so there was no disposition to side with the few members of the Town Council who, without reason, elected to think otherwise. In the Town Council, on the day following the termination of the inquiry, Mr. J. Lyon wished to raise the question of whether notice should be taken of the statements made in the course of the inquiry, which had the effect of maligning the Council; but Lord Provost Gibson pleaded that, the incident being closed, it would be unnecessary and disadvantageous to reopen it. So it was not reopened. The question suggests the small appreciation in which the members are held who led the Council into the inglorious position they occupied last week. The Provisional Order comes into force on the day it receives confirmation by Parliament. Looking to the delays which have taken place in other measures similarly situated, that may be some time yet. It might be overtaken in the autumn session; but, on the other hand, it may be next year before it becomes law.

The Edinburgh and Leith Gas Commissioners held a monthly meeting on Monday, at which it was reported that the Finance and Law Committee had considered the print abstract of the Commissioners' accounts for the year to Whitsunday last, with the relative notes by the Treasurer thereon; and having found the abstract correct, they recommended the Commissioners to allow and certify the accounts, to set apart for the annuities sinking fund and the mortgages sinking fund the statutory minimum contributions—viz., £6891 and £11,834—and for the reserve fund the balance of £4436, being, in addition to £1158,



An Exhibit on Wheels.

At a show inaugurated by the Northwich Gas Co. "EUREKA" Cooking and Heating Appliances were again well to the front. The apparatus exhibited on this tastefully decorated Car was confined **entirely** to Appliances from **Essex Works.**

"EUREKA" goods make money for the Gas Authority—they save money for the Consumer.

JOHN WRIGHT & CO.,
ESSEX WORKS,
BIRMINGHAM.

the minimum statutory contribution. They further recommended that the Commissioners, in annually estimating the price of gas, should make provision for a contribution of £10,000 to the reserve fund. These recommendations were adopted.

It is announced from Perth that there is likely to be a reduction in the price of gas. There seems to be some trouble, however, over the adoption of the annual accounts, due to a draft report by the Auditor—Mr. Cameron, of Inverness—in which he refers to what he calls irregularities in the book-keeping in the gas-meter department. At a special meeting of the Town Council on Thursday, this was founded upon by Mr. M'Kenzie, who considered that the matter should be carefully looked into, and explanations by Mr. M'Lusky received. The Council did not share Mr. M'Kenzie's tremors, and sent the subject to a Sub-Committee to consider and communicate with the Auditor.

In submitting the accounts for the year of the Paisley Gas Trust, on Thursday, Treasurer M'Kean characterized the Trust as the Aladdin's lamp of the Corporation. Last year, he reminded them, the price of gas was raised by 1d. per 1000 feet—due to the increased cost of coal; but this year they were in a better position. Instead of realizing £700 from coke, they had received £1698; and on account of machinery taking the place of hand labour, wages had been £786 lower. The profits, though less than formerly, amounted to £3726, to which must be added the balance from the previous year, £1245; making a sum of £4971 at their disposal. He proposed that this should be allocated as follows: To the burgh general assessment, £2270; to the public health account, £800; to the public parks account, £800; to the public library account, £400; and to the cost of fire alarms, £176—in all, £4446—leaving £525 to be carried forward. As the prospects for the current year were also very good, he felt justified in recommending that the price of gas be reduced by 2d. per 1000 cubic feet for domestic consumption, and by 1½d. for power and heating. The gas charges in the burgh would therefore be: Private lighting, 2s. 3d., motive power, 1s. 10½d., public lamps 2s. 1d. The recommendations were adopted.

The annual meeting of the Loanhead Gas Company, Limited, presided over by Lord Provost Gibson, of Edinburgh, was held on Thursday. A dividend of 5 per cent. was declared.

The Bo'ness Gaslight Company, Limited, have paid a dividend of 5 per cent., and carried forward an increased balance. The make of gas during the financial year was reported by the Manager to have been upwards of 25 million cubic feet.

The Crieff Gas Company, Limited, held their annual meeting on Thursday. It was reported that the profit for the year amounted to £1765, of which £887 was apportioned to the payment of a dividend of 7½ per cent., and the balance of £878 carried to the reserve fund.

The Directors of the Linlithgow Coal Gaslight Company have reduced the price of gas from 3s. 2d. to 3s. per 1000 cubic feet.

The Coatbridge Gas Company have this week reduced the price of gas to 2s. per 1000 cubic feet, and now sell the cheapest gas in Scotland.

At a meeting of the Edinburgh and District Water Trust this week, Mr. T. Wood, the Convener of the Finance Committee, said that the expenditure of the Trust had largely increased since 1895, there having since then been £1,257,977 expended on the Talla scheme, with a further capital expenditure of £255,000 in connection with the Moorfoot new main, additional filter-beds, new offices, &c., so that the sum charged for interest on capital expenditure, which in 1894-5 amounted to £45 415, had risen to £91,834 this year—an increase of £46,419. The increased expenditure had been met by the revenue from year to year, aided by surpluses, until 1906-7. When the surplus revenue was exhausted, the domestic rate had to be raised to 9d., at which it now stood. The estimated income to May 15 last was £161,818, and the expenditure £152,945. The actual income was £161,741, and the expenditure £157,036; leaving £4705, which was utilized for the reduction of the suspense account. The capital expenditure for the year amounted to £62,787; and mortgage loans of £29,300 were paid off by means of the sinking fund. The accounts were approved. The Convener then submitted the estimates of income and expenditure for the current year. The total estimated expenditure was £159,548, and the estimated income £56,704; leaving £102,844 to be raised from the proceeds of the public and domestic water-rates. To meet this sum, the Committee recommended that the Trustees should adhere to all the rates and charges with the exception of the domestic water-rate, which it was proposed to raise to the extent of 1d. in the pound. The estimated surplus as at May 15, 1909, was £12,415, which was to be utilized for the purpose of reducing the debtor balance on the suspense account. The suspense account was created by the Trustees mainly to meet payments to the Clippens Oil Company on account of their interference with the Trustees' mains. The balance at the debit of the suspense account amounted now to £35,000, which included the legal expenses incurred in connection with the various actions; and it was now proposed to pay this out of revenue by three yearly instalments. He moved that the estimates should be adopted, and that the rates in the pound should be 10d. on dwelling-houses, 2d. on shops, public rate 2d., half payable by owner and half by occupier; minimum rate, 4s. per annum; meter-rate for trade purposes, 6d. per 1000 gallons; special rates as in table of rates and charges. This was also agreed to.

In prosecution of the contemplated scheme for the procuring of a new water supply for Aberdeen, and to give new councillors an opportunity of viewing the source of the proposed supply and other works, the Town Council spent two days this week upon visitation work. Driving in motor-cars, they travelled on Monday to Braemar, where they stayed overnight, and on Tuesday traversed Glengairn, where a large reservoir is proposed to be constructed, and went on to see the point upon the River Avon where it is suggested that the water should be impounded. Their progress was, however, stopped by gamekeepers. The councillors returned to the city the same evening. On both days they inspected a number of arrangements which have been made by proprietors and local authorities for keeping pollution out of the River Dee, which is the present source of supply for the city; and in several instances found the arrangements to be working very unsatisfactorily.

In Two Minutes!

THIS was the time occupied in taking an ordinary stock "NEW DAVIS" SCREWLESS COOKER to pieces in the presence of the Junior Engineers on the occasion of their visit to our Luton Works on July 16. Your fitter would have no difficulty in dismantling a "NEW DAVIS" as quickly after years of hard wear.

All we ask is that you should inspect a sample if you have not already done so.

DAVIS—the Gas Stove People.

CAMBERWELL, LONDON, S.E.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *July* 31.

Sulphate of Ammonia.

There has been rather more buying during the week, mainly for the purpose of completing July contracts, and in some cases a slight advance has been scored; but at the close the market is quiet, though fairly steady. The closing quotations are £11 per ton f.o.b. Hull, £11 1s. 3d. to £11 2s. 6d. per ton f.o.b. Liverpool, and £11 2s. 6d. to £11 5s. per ton f.o.b. Leith. For delivery ahead, there has been good inquiry, and business has been done over the late autumn months. The interest of buyers has, however, been chiefly directed to the spring months; but the views of the large makers have made business over this period practically impossible, and at the close buyers have become more indifferent.

Nitrate of Soda.

This article is quiet in all positions; and the spot quotations remain 10s. and 10s. 3d. per cwt. for 95 per cent. and refined qualities respectively.

LONDON, *July* 31.

Tar Products.

There has not been any business of importance during the week in pitch, and the market is still weak. Creosote has improved slightly, and there seems to be a demand both here and in the North. Benzol and naphthas remain unchanged. In crude carbolic, the Continental people are not buyers at present prices; and no sales are reported either for home or for export. Naphthalene and creosote salts are steady.

The average values during the week were: Tar, 11s. 6d. to 15s. 6d., *ex* works. Pitch, London, 18s. to 18s. 6d.; east coast, 17s. to 17s. 6d.; west coast, 16s. to 17s., f.a.s. Benzol, 90 per cent., casks included, London, 7d. to 7¼d.; North, 6¼d. to 6¾d.; 50-90 per cent., casks included, London, 7d to 7¼d.; North, 6¼d. to 6¾d. Toluol, casks included, London, 7¾d.; North, 7d. to 7¼d. Crude naphtha, in bulk, London, 3¼d. to 3½d.; North, 3d. to 3¼d.; solvent naphtha, casks included, London, 10d.; North, 9d.; heavy naphtha, casks included, London, 9¾d. to 10¼d.; North, 8¾d. to 9¼d. Creosote, in bulk, London, 2⅞d. to 2 11/16d.; North, 2¼d. to 2⅜d. Heavy oils, in bulk, 2⅝d. to 3d. Carbolic acid, 60 per cent., casks included, east coast, 1s. 4¾d. to 1s. 5d.; west coast, 1s. 4¼d. to 1s. 4½d. Naphthalene, £4 10s. to £8 10s.; salts, 35s., packages included and f.o.b. Anthracene, "A" quality, 1¼d. to 1½d. per unit, packages included and delivered.

Sulphate of Ammonia.

The market is steady, and business is reported to have been done for Sept.-Dec. in Leith and London at slightly better prices. The principal Gas Companies quote £11 8s. 9d. to £11 10s. Ordinary makes on Beckton terms are £11. In Hull, the prices are £11 to £11 13s.; in Liverpool, £11 1s. 3d. to £11 2s. 6d.; and in Leith, £11 3s. 9d. to £11 5s.

COAL TRADE REPORTS.

Lancashire Coal Trade.

A very large number of gas coal contracts have been concluded in this county on the basis of 6d. per ton below the prices charged last year. There are, however, some gas companies who are still holding aloof in the hope of obtaining lower terms; but there does not appear to be much likelihood of their wishes being gratified. Although the coal trade is quieter in all departments, there is no change in current rates. Town after town is holding its "Wakes;" short time and reduced wages are being advocated on the part of cotton-mill owners; less house and engine fuel is required; and miners are only working three or four days per week. There is no pressure to get rid of "slack," as there was some time ago. Coal for shipping is in lessened request. Furnace coke is quiet. In South Wales coal has been increased in price.

Northern Coal Trade.

There has been a strong demand in the coal trade, with some advance in the prices; the shipment of coals being very heavy at present. In steam coal this is marked; and as some collieries have little fuel for early sale, they are able to ask higher prices. For best Northumbrian steams, the quotation is now from about 14s. 9d. to 15s. per ton f.o.b. for early shipment, with a lower price for delivery a month ahead. Second-class steams are from about 12s. 3d. to 12s. 9d. per ton, and steam smalls vary rather more—from 5s. 9d. to 7s., according to quality. In the gas coal trade, the home deliveries are beginning to increase appreciably, and there are heavy exports, so that the production is well taken up. Durham gas coals are being quoted from 10s. 3d. to 11s. 3d. per ton f.o.b. for ordinary qualities, with "special Wear" kinds at about 11s. 9d. to 12s. Contracts are not so numerous. Berlin has bought about 150,000 tons of Durham gas coals, at prices below those ruling; Ghent a further supply of 18,000 tons, at about 13s. 10d. per ton delivered; while one or two sales for next year's shipment are being considered. As for coke, prices are steady; good gas coke being quoted from about 15s. to 15s. 6d. per ton f.o.b. in the Tyne or Wear.

Scotch Coal Trade.

Work has been resumed at the collieries in the West of Scotland after the holidays, but full time is not being got. For shipment, there is an improved inquiry; but the home market is very weak, on account of many industrial concerns not starting work for a week later than usual. The Conciliation Board last week reduced the miners' wages by 12½ per cent.—equal to 6d. per day. This is the third reduction that has taken place since the end of last year; the first having been 3d. and the other two 6d. per day, or 1s. 3d. in all. The prices quoted are: Ell 10s. 6d. to 12s. 6d. per ton f.o.b. Glasgow, splint 10s. 9d. to 11s., and steam 10s. to 10s. 3d. The shipments for the week amounted to 165,250 tons—a decrease of 165,296 tons upon the preceding week, and of 58,967 tons upon the corresponding week of last year. For the

Richmond's New "STRAND" Double Cooker

Consists of two Ovens which can be used separately or together, each oven being controlled by separate tap—a distinct advantage. The continuous hot plate has two combined grilling and boiling burners and thirteen assorted boiling burners.

Advertisement of the RICHMOND GAS STOVE & METER CO., LTD.

London Offices and Show-Rooms: 132, Queen Victoria Street, E.C. General Offices and Works: Warrington, &c.

year to date, the total shipments have been 7,795,477 tons—a decrease of 291,386 tons upon the corresponding period of 1907.

Gas-Coal Business.

In last Friday's issue of the "Financial Times," a correspondent wrote as follows: "There is little change in the general position of the home gas coal market since a week ago; but it can hardly be denied that the collieries are feeling greater confidence than they have done for some time. Discussing the position with the representative of one of the leading gas-coal collieries in the country, the writer was informed that many of the medium-sized towns in the South and South Midlands had not yet concluded their arrangements for the current twelve months, and were showing considerable reluctance to concede sellers' terms; but for the most part collieries are standing out well, and present indications are that stipulated prices will have to be conceded. The weakness among cheaper qualities of gas fuel, particularly in the Midlands, has been caused by the heavy falling off in the demand from the Continent; but on the north-east coast prices are very firm, and some most satisfactory inquiries are to hand. The Berlin Gas-Works, for instance, have been in the market for 400,000 tons of best gas coal, for delivery over 1909; and so far 150,000 tons of this quantity has been booked on Tyneside. With regard to the balance, no information has been received as to Westphalian producers having secured any portion of it; but it is thought the buyers have certain options which they will exercise or otherwise according to the comparative run of prices on the north-east coast. Durham collieries have sold fair quantities to the Ghent Gas-Works; while tenders are at present being sent in for 12,000 tons for the Leghorn Gas-Works, and Porto Vecchio is in the market for 50,000 tons of Durham coking coal for delivery from August to March."

More Unprofitable Electricity Undertakings.

When moving the adoption by the Loughborough Town Council of the minutes of the Electricity Committee, Alderman Bumpus said that the balance-sheet of the undertaking for the year to March 31 last was more unsatisfactory than they had expected; and a Sub-Committee had been appointed to go thoroughly into the accounts. When this had been done, the statement would be presented to the Council. Mr. Phelps asked what was the loss per week on the undertaking. He had been told it amounted to £30. The Mayor, however, replied that he would have to wait until the Sub-Committee reported. Last Friday week, at Gillingham, Mr. H. R. Hooper, of the Local Government Board, held an inquiry into the management of the electric light undertaking of the Gillingham Corporation. Some time back, an application was made by the Corporation to borrow more money for carrying on the undertaking (which, it is stated, is being run at a considerable loss to the ratepayers); but the Local Government Board refused to give their sanction until they had conducted an inquiry. The public were not admitted to the proceedings; but members of the Corporation were present.

The Trial of Mr. H. W. Gyde for Conspiracy.

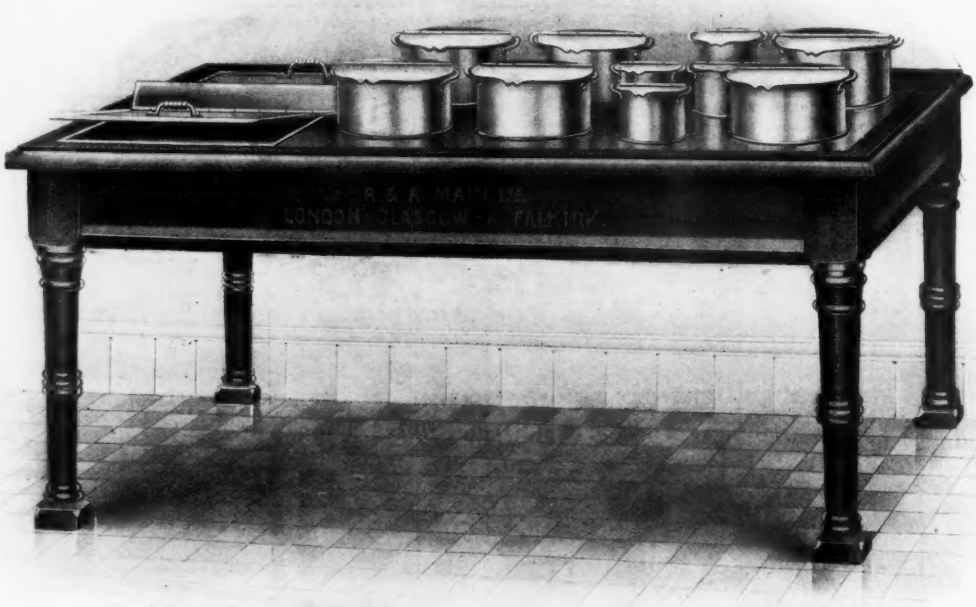
In the King's Bench Divisional Court last Tuesday, Mr. Graham Campbell showed cause against the rule obtained on the 14th ult. for the removal of the indictment from the Central Criminal Court to the King's Bench Division (see *ante*, p. 197). He said he appeared on behalf of the Public Prosecutor, and submitted that not one of the grounds alleged in the rule was sufficient. These grounds were: (1) That it was desirable that the case should be tried by a Special Jury; (2) that it was important that some of the Jury should have a view of the premises; and (3) that the defendant would not get a fair and impartial trial at the Central Criminal Court. Mr. F. E. Smith, K.C., and Mr. G. Elliott, supported the rule. In the result, Justices Lawrance, Jelf, and Sutton unanimously decided to discharge the rule, with costs. The trial will consequently take place at the Old Bailey in due course.

To Increase the Consumption of Electric Current.

An Electricity Company who are doubtless desirous of increasing their business have issued the following circular to consumers who appear to them to be too careful in the use of current. The task of satisfying himself as to what is likely to be the extent of the advantage he would gain by accepting the offer, should provide quite a nice little mental exercise for the consumer: "As we notice that you do not make much use of the electric light, and thinking that you may find the cost too high, we are prepared to make the following offer for houses with not more than six 8-candle power lamps (or their equivalent): To supply current for the inclusive charge of 6d. per week in the months of May, June, July, and August; 9d. per week in the months of March, April, September, and October; and 1s. per week during January, February, November, and December. These payments to be made each Saturday morning in advance; or failing payment, the supply to be disconnected. For these sums, you can use as much electricity as you please up to a maximum of 12 units per quarter in the summer quarters, and 24 units per quarter in the winter quarters. With reasonable care, your requirements are not likely to exceed this amount; but if they do, we shall charge you 1d. per unit for all in excess at the end of each quarter. We shall be glad to hear if you wish to adopt these very favourable terms."

The Uxbridge Gas Company have announced a reduction of 2d. per 1000 cubic feet in the price of gas. Referring to the matter, a local paper says: "Seeing how this Company forbore to raise the price of gas when the coal rates rose, to have now already reduced it shows the spirit and determination to place at the hands of the traders and working class consumers alike not only the best illuminant and heating agent, but far away the cheapest; and we wish them good speed in their liberal and far-sighted policy."

LARGE POLISHED COPPER
"BAIN MARIE."



FOR HOTELS,
RESTAURANTS, &c.

R. & A. MAIN, LTD.
LONDON, GLASGOW, FALKIRK.

Plymouth Corporation Water Supply.

With a slight change in the arrangements, the Plymouth Corporation on Tuesday last carried out the usual formalities of the "Fyshinge Feaste." The pious memory of Sir Francis Drake was duly toasted in water, and then followed in wine the quaint toast "May the descendants of him who brought us water never want wine." The muster, instead of being at the intake of the Burrator reservoir, near the spot where Drake constructed the weir which diverted the water of the River Meavy to Plymouth, was at the foot of the reservoir dam, a mile or so away. The party drove out from Plymouth, inspecting on the way the various reservoirs and other works, particularly those connected with the recent duplication of a portion of the trunk main. At the dinner which followed the ceremony, Mr. C. H. Tozer, the Chairman of the Water Committee, gave some statistics with regard to the undertaking. He said the income this year was £32,219, and £32,011 last year. The gross profit was £22,351, against £22,300; and after paying £17,544 for interest, sinking fund, and income-tax, there was a net profit of £4807, which was £87 more than last year. At present there was an annual charge of £1200 on the undertaking for an interest suspense account; but in two years this would be wiped off, and the profit would be increased by this amount. The mains had been extended by 2¼ miles during the year; and now reached a total length of 132 miles. In the administrative area, the consumption per head per day was 36·31 gallons, against 36·61 gallons last year; while the domestic consumption in the borough was 26·5 gallons, against 26 65 gallons. The cost of the new main up to date had been £11,765; and it was anticipated that it would be completed for £12,000, against an estimate of £13,317. The length was 3 miles, consisting of about 2 miles of 24-inch, ¾ mile of 20-inch, and ¼ mile of 18-inch pipe. They had yet to undertake the laying of the alternative pipe from the Burrator storage reservoir to the Roborough service reservoir, in order to secure a continuous supply of water. This work required serious attention, and would of necessity be carried out shortly.

Filtering Plant for the Portsmouth Water Company.—Good progress is being made with the large filter-beds now being constructed on Portsdown Hill for the Portsmouth Water Company; and it is expected that in two years all the Company's supply will be filtered. The beds alone cover an area of 10 acres, and all the material is being conveyed on a miniature light railway from the main line at Farlington Siding.

Suicide by Gas at Bristol.—At an inquest held in Bristol on the body of a plumber and gas-fitter, the Jury returned a verdict of "Suicide while of unsound mind." Deceased was found in his shop with a handkerchief pinned over his head. A piece of rubber-piping had been attached to a gas-jet, which was turned on; and the other end he had in his mouth, a cord being fixed round his neck to keep the end of the pipe in position.

Sales of Shares.—At a recent sale by Messrs. Waters and Rawlence, eight fully-paid £12 10s. ordinary 10 per cent. shares in the Salisbury Gas Company realized from £26 to £26 15s. each; and eight 5 per cent. shares of the same nominal value fetched £13 12s. 6d. and £14 10s. apiece. By order of the Directors of the Portsmouth Water Company, the tenth and final sale of shares under the Water Order of 1902 was conducted by Mr. E. H. Cooper last Tuesday. There was a crowded attendance; the shares being eagerly sought for, and the demand greater than the supply. The necessary number (viz., 1471) were sold, and realized £9023; equal to an average of £6 2s. 8d. per share. On the same day, Messrs. Burtenshaw and Son sold some "A" shares in the Newhaven and Seaford Water Company, the maximum dividend on which is 10 per cent. per annum, at prices ranging from £15 to £16 apiece.

APPLICATIONS FOR LETTERS PATENT.

15,310.—Griffin, S., "Gas-producers." July 20.
15,336.—Del Taglia, A., "Pump for wells of great depth." July 20.
15,360.—Parson, H. E., "Blowers." July 20.
15,399.—Gillie, W. S., "Pressure-raising apparatus." July 21.
15,412.—May, W., "Radiators for gas cooking-stoves." July 21.
15,505.—Schumacher, Q., "Section of ammonia still." July 22.
15,549.—Cohn, S., "Mantles." July 22.
15,621.—Branston, F. R. E., "Intensive gas-stoves." July 23.
15 630.—Ullrich, R., "Gas-signs." July 23.
15,637.—Brockman, H. E., "Safety gas-cocks." July 23.
15,639.—Hodge, W. J., "Gas-engines." July 23.
15,644.—Sugg, W., and Co., Ltd., and Sugg Wright, E., "Incandescent burners." July 23.
15,649.—Boeckel, A., Grunberg, O., Corwin-Krukovsky, G. de, and Luxembourg, E., "Steam or gas turbine." July 23.
15,711.—Taylor, C. & G. B., "Gas-tap." July 24.
15,712.—Hudson, E. H., "Differential testing meter for gas." July 24.
15,717.—Adair, J., and Another, "Conveying coal, and also weighing same." July 24.
15,746.—Lafitte, J., "Long distance lighting." July 24.
15,756.—Symour, H., and Smith, E. H., "New or improved fuel or material for producing light, heat, and motive power." July 24.
15,757.—Rice, H. A., "Converting liquid fuel into combustible gas, and utilizing the combustible gas for the production of light and heat." July 24.
15,782-3.—Yates, H. J., "Gas-fires." July 24.
15,845.—Heuer, F., "Inverted fitting." July 25.
15,846.—Drake, B. M., Fox, H. C. J., and Drake and Gorham, Ltd., "Control of taps from a distance." July 25.
15,861.—Aubert, A. M. & J. M., "Controlling from a distance the passage of gas." July 25.

THE
PARKINSON
STOVE CO., LTD.
SLOT COOKERS

Intermediate Grade
COOKERS.

Write—
THE PARKINSON STOVE COMPANY, LTD.,
Stour Street, Spring Hill,
BIRMINGHAM.

Additional Capital for the Devon Gas Association.—The Devon Gas Association are inviting a subscription of £3500, in £10 shares, for the purpose of developing their business. The Company have acquired the gas-works at Chagford, Chudleigh, and Moretonhampstead, and have erected works at South Brent. The money required is in connection with the last-named works, which have been newly built.

Messrs. Robert Dempster and Sons, Limited, of Elland, have secured the contract for building complete gas-works at Sant Feliu de Guixols, in Spain. The order was obtained in competition with German and French firms.

A comparative test of lead wool and cast lead joints in cast-iron pipe has lately been carried out in the Hydraulic Laboratory of the University of Toronto; the results being as follows: Cast lead: Size of pipe, 4 inches. Weight of lead used, 4 lb. 8½ oz. Joint began to sweat at 400 lb. per square inch. Joint leaked freely at 610 lb. per square inch. By raising the pressure slightly above 610 lb.—it being at no time greater than 700 lb.—the joint failed completely, the spigot pulling out of the socket. Lead wool: Size of pipe, 4 inches. Weight of lead used, 2 lb. 8 oz. Joint began to sweat at 800 lb. per square inch. Joint leaked freely at 1150 lb. per square inch. In an attempt to make this joint pull out as the cast lead joint did, the pressure was raised to 1200 lb., at which pressure the cap on one end of the pipe failed. We learn that lead wool joints have lately been adopted in connection with 9½ miles of 36-inch pipes at Wigan, for some 17-inch to 42-inch diameter pipes at Tamworth, and for the new 14-inch and 15-inch cast-iron syphon at Guildford.

"ILLUMINATING TRUTHS."

LEAFLETS FOR DISTRIBUTION.

No. 1.—"The Sanitary Aspects of Gas and Electric Lighting."
No. 2.—"The Cleanliness of Illuminants: The Eyesight."
No. 3.—"Fire Risks."
No. 4.—"The Relative Cost of Gas and Electricity, and Matters affecting it."
No. 5.—"On Reliability, with Instances of Misplaced Confidence."
No. 6.—"On Shop Lighting, with Special Reference to the Flame Arc Lamp."
No. 7.—"The Osram Lamp: Fiction and Fact."

This series of Leaflets will be useful, not only for distribution among Householders generally, but for circulation among Shareholders to fortify them with arguments in defence of the commodity in which they have invested capital. Copies of each Leaflet should also be kept in every Gas Undertaking's Show-Rooms.

Prices for Quantities on Application to WALTER KING, 11, BOLT COURT, FLEET STREET, E.C.

WANTED, FOR SALE, CONTRACT, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Situations Vacant.

AGENTS FOR PURCHASING AMMONIA AND TAR. No. 4971.
DISTRICT SUPERINTENDENT (GAS AND WATER). No. 4972.
REPRESENTATIVE (METER TRADE). No. 4974.

Pupil Required. No. 4969.

Plant (Second-Hand) for Sale.

RETORT BENCH MOUNTINGS, PIPES, &c. Lochgelly Gas Company.

Plant, &c. (Second-Hand) Wanted.

STATION METER. Centenary Air Gas Plant Company, Glasgow.
WATER-GAS PLANT. "L 69," care of Lee and Nightingale's Advertising Offices, Liverpool.

Inventions Wanted.

LIGHTING, HEATING, MANUFACTURING, &c. No. 4973.

Patents to Sell or Licences to Manufacture.

ACETYLENE LAMPS AND GENERATORS, &c. Haseltine, Lake, and Co., Southampton Buildings, W.C.
LAUNDRY IRONS AND HEATERS. Cruikshank and Fairweather, Chancery Lane, W.C.
PIPE COUPLINGS. Lloyd Wise and Co., Lincoln's Inn Fields, W.C.

Meetings.

BRENTFORD GAS COMPANY. St. Ermin's Hotel. Aug. 7. 2.30 o'clock.
SOUTHGATE GAS COMPANY. London Office. Aug. 20. 3.45 o'clock.

TENDERS FOR

Coal and Cannel.

BRADFORD GAS DEPARTMENT. Tenders by Aug. 27.
DALTON-IN-FURNESS URBAN DISTRICT COUNCIL. Tenders by Aug. 15.
HAVERFORDWEST CORPORATION. Tenders by Aug. 18.
LYMM URBAN DISTRICT COUNCIL. Tenders by Aug. 19.
MOSSLEY GAS DEPARTMENT. Tenders by Aug. 11.
WARRINGTON GAS DEPARTMENT. Tenders by Aug. 6.

Cookers.

WARRINGTON GAS DEPARTMENT. Tenders by Aug. 6.

Fire Clay Goods.

WARRINGTON GAS DEPARTMENT. Tenders by Aug. 6.

Gas-Works Reconstruction, &c.

ST. PETERSBURG MUNICIPAL COUNCIL.

General Stores (Benzol, Lime, Lead, Tubing, Lamps, Burners, Glass, Iron and Steel, Oil, Paints, Taps, Valves, &c., &c.)

ROCHESTER CORPORATION. Tenders by Sept. 1.
WARRINGTON GAS COMMITTEE. Tenders by Aug. 6.

Meters.

WARRINGTON GAS DEPARTMENT. Tenders by Aug. 6.

Pipes, &c.

DALTON-IN-FURNESS URBAN DISTRICT COUNCIL. Tenders by Aug. 15.
HEYWOOD GAS DEPARTMENT. Tenders by Aug. 18.
WARRINGTON GAS DEPARTMENT. Tenders by Aug. 6.

Sulphuric Acid.

HEYWOOD GAS DEPARTMENT. Tenders by Aug. 18.

Tank (Cast-Iron) Enlargement.

HINCKLEY URBAN DISTRICT COUNCIL. Tenders by Aug. 26.

Tar and Liquor.

HEYWOOD GAS DEPARTMENT. Tenders by Aug. 18.
LYMM URBAN DISTRICT COUNCIL. Tenders by Aug. 19.

Well Sinking, &c.

HINCKLEY URBAN DISTRICT COUNCIL. Tenders by Aug. 26.

GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 300.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
590,000	10	Apl. 10	10	Alliance & Dublin 10 p.c.	19–20	..	5 0 0
268,324	10	,,	7	Do. 7 p.c.	13–14	..	5 0 0
310,000	Stk.	July 15	4	Do. 4 p.c. Deb.	99–102	..	3 18 5
200,000	5	May 29	6½	Bombay, Ltd.	6–6¼	..	5 0 0
40,000	5	,,	6½	Do. New, £4 paid	4¼–4¾	..	5 9 6
50,000	10	Feb. 27	14	Bourne-mouth Gas and Water } 10 p.c.	28½–29½	..	4 14 11
51,810	10	,,	7	Do. B 7 p.c.	16½–16⅝	..	4 3 7
53,200	10	,,	6	Do. Pref. 6 p.c.	14⅜–15½	..	3 17 5
380,000	Stk.	,,	12½	Brentford Consolidated	242–247	..	5 1 3
300,000	,,	,,	9¾	Do. New	180–185	..	5 2 8
50,000	,,	,,	5	Do. 5 p.c. Pref.	120–125	..	4 0 0
206,250	,,	June 12	4	Do. 4 p.c. Deb.	100–105	..	3 16 2
220,000	Stk.	Mch. 12	11½	Brighton & Hove Orig.	208–213	..	5 5 5
246,320	,,	,,	8½	Do. A. Ord. Stk.	152–157	..	5 5 1
460,000	20	Mch. 27	10	British	41–43	..	4 13 0
104,000	Stk.	Feb. 13	6	Bromley, Ord. 5 p.c.	116–119	..	5 0 10
165,700	,,	,,	4½	Do. do. 3½ p.c.	86–89	..	5 1 2
500,000	10	May 14	7	Buenos Ayres (New) Ltd.	11–11⅛	..	6 1 9
250,000	Stk.	June 26	4	Do. 4 p.c. Deb.	91–93	..	4 6 0
150,000	20	July 15	7½	Cagliari, Ltd.	24–25	..	5 16 0
100,000	10	—	—	Cape Town & Dis., Ltd.	4–6	..	—
100,000	10	Apl. 26	4½	Do. 4½ p.c Pref.	5–7	..	6 8 7
50,000	50	May 2	6	Do. 6 p.c. 1st Mort.	47–49	..	6 2 5
103,000	Stk.	June 26	4½	Do. 4½ p.c. Deb. Stk.	78–83	..	5 8 5
157,150	Stk.	Feb. 27	5	Chester 5 p.c. Ord.	111–113	..	4 8 6
1,493,280	Stk.	Mch. 12	5⅝	Commercial 4 p.c Stk.	106–111	..	4 13 8
560,000	,,	,,	5	Do. 3½ p.c. do.	101–106	..	4 14 4
475,000	,,	June 26	3	Do. 3 p.c. Deb. Stk.	81–83	..	3 12 3
800,000	Stk.	June 12	6½	Continental Union, Ltd.	110–115	..	5 13 1
200,000	,,	,,	7	Do. 7 p.c. Pref.	136–141	..	4 19 3
460,170	Stk.	—	5½	Derby Con. Stk.	121–123	..	4 9 5
55,000	,,	—	4	Do. Deb. Stk.	103–105	..	3 16 2
148,995	,,	Mch. 31	5	East Hull 5 p.c. Ord.	100–103	..	4 17 1
486,090	10	July 15	12	European, Ltd.	22½–23½	..	5 2 2
354,060	10	,,	12	Do. £7 10s. paid	16½–17½	+½	5 2 10
15,182,590	Stk.	Feb. 13	4/10/8†	Gas-light and Coke } 4 p.c. Ord.	99–100	+½	4 10 8
2,600,000	,,	,,	3½	3½ p.c. max.	87–90	..	3 17 9
3,799,735	,,	,,	4	4 p.c. Con. Pref.	106–109	..	3 13 5
4,193,975	,,	June 12	3	3 p.c. Con. Deb.	83–85	..	3 10 7
258,740	Stk.	Mch. 12	5	Hastings & St. L. 3½ p.c.	93–93	..	5 2 0
82,500	,,	,,	6½	Do. do. 5 p.c.	112–115	..	5 13 1
70,000	10	Apl. 29	11	Hongkong & China, Ltd.	18–19	..	5 15 9
4,940,000	Stk.	May 14	8	Imperial Continental	179–182	..	4 7 11
473,600	Stk.	Feb. 13	3½	Do. 3½ p.c. Deb. Red.	95–97	..	3 12 2
195,242	Stk.	Mch. 12	6	Lea Bridge Ord. 5 p.c.	113–118	..	5 1 8
561,000	Stk.	Feb. 27	10	Liverpool United A	232–234	..	4 5 6
718,100	,,	,,	7	Do. B	165–167	..	4 3 10
306,083	,,	June 26	4	Do. Deb. Stk.	104–106	..	3 15 6
152,736	Stk.	Feb. 13	7⅝	Maidstone 5 p.c.	136–141	..	5 8 2
75,000	5	June 26	6	Malta & Medn., Ltd.	4½–4¾	..	6 6 4
560,000	100	Apl. 1	5	Met. of } 5 p.c. Deb.	101–103	..	4 17 1
250,000	100	,,	4½	Melbourne } 4½ p.c. Deb.	101–103	..	4 7 5
541,920	20	May 29	3½	Monte Video, Ltd.	11–12	..	5 16 8
1,775,892	Stk.	Feb. 27	4/12/6	Newc'tle & G'tesh'd Con.	108–109	..	4 4 10
418,460	Stk.	June 26	3½	Do. 3½ p.c. Deb.	90–92	..	3 16 1
15,000	10	Feb. 27	10	North Middlesex 10 p.c.	20–21	..	4 15 3
55,940	10	,,	7	Do. 7 p.c.	13½–14½	..	4 16 7
300,000	Stk.	Apl. 29	8	Oriental, Ltd.	140–143	..	5 11 11
60,000	5	Mch. 27	7	Ottoman, Ltd.	6–6½	..	5 7 8
398,490	5	Apl. 29	7	Primitiva Ord.	6–6½	..	5 7 8
796,980	5	July 30	5	Do. 5 p.c. Pref.	4⅞–5⅛*	..	4 17 7
488,900	100	June 1	4	Do. 4 p.c. Deb.	93–95	+1	4 4 3
1,000,000	10	Apl. 29	8	River Plate Ord.	13½–13¾	..	5 16 5
312,650	Stk.	June 26	4	Do. 4 p.c. Deb.	91–93	..	4 6 0
250,000	10	Apl. 10	8	San Paulo, Ltd.	13⅝–14	..	5 14 4
125,000	50	July 1	5	Do. 5 p.c. Deb.	49–51	..	4 18 0
135,000	Stk.	Mch. 12	10	Sheffield A	245–246	..	4 1 4
209,984	,,	,,	10	Do. B	244–246	..	4 1 4
523,500	,,	,,	10	Do. C	244–246	..	4 1 4
70,000	10	May 29	10	South African	13–14	..	7 2 10
6,429,895	Stk.	Feb. 13	5/6/8	South Met., 4 p.c. Ord.	119–121	..	4 8 1
1,895,445	,,	July 15	3	Do. 3 p.c. Deb.	83–85	..	3 10 7
209,820	Stk	Mch. 12	8	South Shields Con. Stk.	155–157	..	5 1 11
605,000	Stk.	Feb. 27	5/6/8	S'th Suburb'n Ord. 5 p.c.	116–119	..	4 9 7
60,000	,,	,,	5	Do. 5 p.c. Pref.	120–125	..	4 0 0
117,058	,,	July 15	5	Do. 5 p.c. Deb. Stk.	120–125	..	4 0 0
502,310	Stk.	May 14	5	Southampton Ord.	105–110	..	4 10 11
120,000	Stk.	Feb. 27	6½	Tottenham } A 5 p.c.	120–125	..	5 8 0
398,940	,,	,,	5½	and } B 3½ p.c.	107–109	..	4 16 4
149,470	,,	June 26	4	Edmonton } 4 p.c. Deb.	98–103	..	3 17 8
182,380	10	June 12	8	Tuscan, Ltd.	10–10½	..	7 12 4
149,900	10	July 1	5	Do. 5 p.c. Deb. Red.	99–101	+2	4 19 0
193,742	Stk.	Feb. 27	5	Tynemouth 5 p.c. max.	106–107	..	4 13 6
255,636	Stk.	Feb. 13	6½	Wandsworth } B 3½ p.c.	128–133	..	4 17 9
80,075	,,	June 26	3	and } 3 p.c. Deb. Stk.	72–77	..	3 17 11
845,872	,,	Feb. 27	5⅛	West Ham 5 p.c. Ord.	100–102	..	5 0 6
185,000	,,	,,	5	Do. 5 p.c. Pref.	120–125	..	4 0 0
228,300	,,	June 26	4	Do. 4 p.c. Deb. Stk.	100–105	..	3 16 2

Prices marked * are "Ex div." † Next dividend will be at this rate.

BOOKS AND LEAFLETS

TO BE OBTAINED OF

WALTER KING,

11, BOLT COURT, FLEET STREET, E.C.

HANDBOOK FOR GAS ENGINEERS AND MANAGERS.—By THOMAS NEWBIGGING, M.Inst.C.E. (7th Edition. *Price 18s. net.*

PRACTICAL GAS FITTING.—By PAUL N. HASLUCK. With 120 Illustrations. *Price 2s. 3d., post free.*

AUTOMATIC METER REGISTER.—By ROBERT P. KEYS. *In sizes to record 1000 Meters, with Index, half bound, 42s.; to record 500 Meters, 35s.; to record 250 Meters, 31s. 6d.*

GASHOLDERS WITH OR WITHOUT GUIDE-FRAMING.—A Discussion between E. LLOYD PEASE and F. SOUTHWELL CRIPPS. *Price 1s.*

CALORIMETRY OF PRODUCER AND ILLUMINATING GASES.—By JOHN F. SIMMANCE, Assoc. M.Inst.C.E., M.Inst.Mech.E. *Price 2s.*

DOWDING'S WAGES TABLES, Calculated for Wages payable by the hour.—By EDWIN DOWDING. *Price 3s. 6d.*

MOND GAS SCHEME.—By F. N. KEEN, of the Middle Temple, Barrister-at-Law. *Price 1s.*

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THE Gas Committee invite Tenders for the Supply of TUBES and FITTINGS, SULPHURIC ACID, and also for the Purchase of SURPLUS TAR.
Specification and Form of Tender may be obtained upon Application to Mr. W. Whatmough, Gas Manager.
Contractors Tendering for this work must pay their workpeople at least the Standard or Trade Union Rate of Wages, and observe the Trade Conditions which attach to the various kinds of Work for which the Tender is sent in.
Sealed and endorsed Tenders to be sent to me not later than Tuesday, Aug. 18, 1908.
By order,
Geo. G. Bouchier,
Town Clerk.
Municipal Buildings,
Heywood, July 15, 1908.

CITY OF ROCHESTER.

CONTRACT FOR STREET-LAMPS.

THE Corporation are prepared to receive TENDERS for the Supply of 106 STREET-LAMPS fitted with Incandescent Burners.
Full Particulars can be obtained on Application to Mr. William Banks, Assoc.M.Inst.C.E., City Surveyor, Guildhall, Rochester.
Sealed Tenders, endorsed "Tender for Street-Lamps," are to be delivered at my Offices before Four o'clock on Tuesday, the 1st of September, 1908.
The Corporation do not bind themselves to accept the lowest or any Tender.
By order,
Apsley Kennette,
Town Clerk.
Guildhall, Rochester,
Aug. 1, 1908.

HINCKLEY URBAN DISTRICT COUNCIL WATER-WORKS.

TO MAKERS OF CAST-IRON TANKS.

Contract No. 1.

THE Urban District Council for the Urban District of Hinckley are prepared to receive TENDERS for the Enlargement of the High-Level CAST-IRON TANK on the Tower at their Water-Works at Hinckley.
The Plans may be inspected and Specification and Form of Tender may be had on payment of the sum of Two Guineas (to be returned on receipt of a *bonâ-fide* Tender) on Application at the Office of the Surveyor at the Council Offices, Hinckley, or at the Office of Messrs. T. & C. Hawksley, 30, Great George Street, Westminster, S.W., on or after Monday, the 10th day of August, 1908, and Tenders must be delivered at my Office at the Council Offices, Hinckley, at or before Noon on Wednesday, the 26th day of August, 1908.
The Council do not bind themselves to accept the lowest or any Tender.
A. S. Atkins,
Clerk.
Council Offices,
Hinckley, Aug. 1, 1908.

HINCKLEY URBAN DISTRICT COUNCIL WATER-WORKS.

TO WELL SINKERS.

Contract No. 2.

THE Urban District Council for the Urban District of Hinckley are prepared to receive TENDERS for the Construction of a PILOT SHAFT and HEADINGS or DRIFTS at Snarestone, adjacent to their Snarestone Pumping-Station.
The Plans may be inspected and Specification and Form of Tender may be had on payment of the sum of Two Guineas (to be returned on receipt of a *bonâ-fide* Tender) on Application at the Office of the Surveyor, at the Council Offices, Hinckley, or at the Office of Messrs. T. & C. Hawksley, 30, Great George Street, Westminster, S.W., on and after Monday, the 10th day of August, 1908; and Tenders must be delivered at my Office at the Council Offices, Hinckley, at or before Noon on Wednesday, the 26th day of August, 1908.
The Council do not bind themselves to accept the lowest or any Tender.
A. S. Atkins,
Clerk.
Council Offices,
Hinckley, Aug. 1, 1908.

CITY OF BRADFORD.

TO COLLIERY PROPRIETORS AND OTHERS.

THE Gas Committee of the Bradford Corporation are prepared to receive TENDERS for the Supply of Best GAS COAL COBBLES, NUTS, and CANNEL, all to be Well Screened, Dressed, and free from Shale and Pyrites, to be delivered at the several works of the Corporation during the period of One Year, commencing on the 1st day of October next.
Form of Tender, with any further Information required, may be had on Application to Mr. Chas. Wood, Gas Engineer, Town Hall.
Sealed Tenders, endorsed "Tender for Coal," to be sent to me on or before Thursday, the 27th of August next.
The Contracts will be let subject to the Fair Contracts Clauses of the Corporation, which may be seen at the Town Clerk's Office, and which the accepted Contractors will be required to sign.
The lowest or any Tender will not necessarily be accepted.
Frederick Stevens,
Town Clerk.
Town Hall, Bradford,
July 31, 1908.

BOROUGH OF MOSSLEY.

THE Gas Committee of the Borough of Mossley invite TENDERS for the Supply of GAS COAL.
Specifications and Forms of Tender may be obtained from the undersigned.
Sealed Tenders, endorsed "Gas Coal," and addressed to the Chairman of the Gas Committee, Gas-Works, Mossley, must be delivered not later than the First Post on Tuesday Morning, Aug. 11.
James Taylor,
Engineer and Manager.
Gas-Works, Mossley,
July 14, 1908.

COUNTY BOROUGH OF WARRINGTON.

THE Gas Committee invite Tenders for the undermentioned GOODS.
Full Particulars can be obtained on Application to Mr. W. S. Haddock, Gas Engineer, Warrington.
All Inquiries must be made before the 6th of August next.

1.—Bags.
2.—Bolts and Nuts.
3.—Brass and Copper Tubing.
4.—Brass Fittings.
5.—Builders' Ironmongery.
6.—Cast-Iron Pipes and Connections.
7.—Cement.
8.—Castings.
9.—Clothing.
10.—Copper Street Lamps.
11.—Cookers.
12.—Common, Paving, and other Bricks.
13.—Fire-Bricks, Fire-Clay, and Retorts.
14.—Flexible Tube.
15.—Glass.
16.—Iron and Steel.
17.—Lead and Compo. Pipe.
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21.—Rails, Crossings, Fastens, &c.
22.—Red and White Lead.
23.—Setts.
24.—Timber.
25.—Wet and Dry Gas-Meters.
26.—Wrought-Iron Tubes and Fittings.
27.—Coal, Slack, or Nuts, 30,000 tons.
28.—Cannel, 6000 Tons.
29.—Benzol, 7000 Gallons.
30.—Taps, Valves, &c.

Fredk. Taylor,
Secretary.
Gas Offices, Warrington,
July 25, 1908.